1909-10, to 1916-17 (except 1911-12)

GENERAL REPORT

SURVEY OF INDIA

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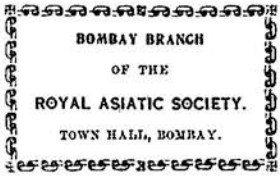

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GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India,

DURING THE SURVEY YEAR

1909-10. to 1916-17
(except 1911-12)

134607
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PREPARED UNDER THE DIRECTION OF

COLONEL S. G. BURRARD, R.E., F.R.S.,

OFFG. SURVEYOR GENERAL OF INDIA.

Printed at the Photo.-Litho. Office, Survey of India,

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GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1909-1910.

PART I.

ADMINISTRATION.

1. This report deals with the operations of the Survey of India for the year ending 30th September 1910.

2. Orders were received during the year sanctioning the scheme for the re-organisation of the department, and laying down a time scale of pay, combined with charge allowances, for military officers.

The re-organisation provides for (*i*) three topographical circles, called the Northern, Southern and Eastern respectively, each under a Superintendent; (*ii*) twelve topographical parties, four to each circle; (*iii*) six trigonometrical parties, under the Superintendent, Trigonometrical Surveys; (*iv*) one Superintendent in charge of the Map Publication Office at Headquarters, with two officers under him in charge of the Photo.-Litho. and Drawing Offices respectively.

3. In pursuance of this scheme India has been divided into three circles, to which areas have been apportioned as found most convenient for topographical purposes, and parties have been re-numbered from 1 to 18, of which Nos. 1 to 12 are topographical, and 13 to 18 trigonometrical and geodetic. This has involved the amalgamation of old Nos. 2 and 17 parties to form new No. 6 Party, the absorption of the Quetta Party in No. 9 Party which retains its old number, and the formation of a new party in the trigonometrical branch.

Parties will be referred to by their new numbers throughout this report.

4. In August 1910 a committee was appointed by the Government of India to consider the grievances of officers of the Old Provincial Service and to report as to how far such grievances are real and require a remedy.

5. Four probationary Sub-Assistant Superintendents and two probationary Upper Subordinates of the Survey of India, and three probationary Assistant Superintendents of the Burma Land Records Department, were put through a course of training at Dehra Dún during the year, while eleven probationary Upper Subordinates of the Survey of India were attached to various circle and party offices for training.

6. The cost of the department for the survey year ending 30th September 1910 was Rs. 33,50,953, while that for the financial year ending 31st March 1910 was Rs. 32,55,495, against an estimated cost for the year 1910-11 of Rs. 34,98,720. The actual expenditure on topographical surveys for the survey year amounted to Rs. 19,02,964 against Rs. 16,51,677 for the previous year.

7. The distribution of officers in the various offices and parties throughout the year is shown in the following list:—

DISPOSITION OF OFFICERS,

1909-1910.

Circle.	Administrative Officer.	Party or Office.	Locality.	Imperial Officers.	Provincial Officers.	Upper Subordinates.	Lower Subordinate Establishment.	REMARKS.
MAP PUBLICATION.	The Hon'ble Colonel F. B. Longe, C.B., R.E., A.D.C., *Surveyor General of India.*	.....	Calcutta ...	.....	.....	.....	.....	
		Surveyor General's Office.	Calcutta ...	Colonel T. F. B. Renny-Tailyour, R.E., Major H. L. Crosthwait, R.E., Major G. P. Lenox-Conyngham, R.E., Captain R. H. Thomas, R.E.	.....	.....	.....	
		Mathematical Instrument Office.	Calcutta ...	Major J. M. Burn, R.E., Major H. L. Crosthwait, R.E., Major G. P. Lenox-Conyngham, R.E., Captain R. H. Thomas, R.E.	.....	.....	.....	
		Map Publication Office.	Calcutta ..	.....	Mr. M. Gastaud ...	.....	.....	Special establishments.
	Major W. M. Coldstream, R.E., up to 26th February 1910, Lieut.-Colonel J. M. Fleming, I.A., from 27th February 1910 to 9th July 1910, Major G. P. Lenox-Conyngham, R.E., from 10th July 1910, *Superintendents, Map Publication.*	Drawing Office	Calcutta ...	Captain M. O'C. Tandy, R.E.	Messrs. C. A. Norman, P. J. Barrington, A. B. Smart, J. O. Greiff, Jagdamba Prasad, P. L. Cansley, J. R. Newland, P. Simpson, P. N. Sur, *J. Hickie*, (re-employed).	.....	.....	
		Photo.-Litho. Office.	Calcutta ..	Lieut. O. H. B. Trenchard, R.E., Lieut. K. W. Pye, R.E.	.....	.....	.....	
		Map Record and Issue Office.	Calcutta ..	Captain M. O'C. Tandy, R.E.	..	.....	.....	
		Engraving Office	Calcutta ...	Captain M. O'C. Tandy, R.E.	.	.....	.....	
					Mr. E. G. Hardinge (Bengal Drawing Office, Imperial Section).			

NORTHERN.	Bt.-Colonel W. J. Bythell, R.E., *Supdt., Northern Circle.*	Northern Circle Drawing Office.	Mussooree ...	.....	Messrs. G. P. Tate, B. R. Hughes, M. C. Petters, *J. Marten*, (re-employed).	Husain Buksh, K. S.	59 Clerks, Draftsmen, &c.	
		No. 1 Party ...	N. W. F. Province, Punjab and Kashmir.	Major C. H. D. Ryder, R.E., Lieut. J. D. Campbell, R.E., Lieut. A. A. Chase, R.E.	Messrs. T. W. Babonau, H. H. B. Hanby, H. B. Simons, R. C. Hanson, W. J. B. Miller, W. P. Hales.	Natha Singh, R.S., Mahindar Singh, Mhd. Husain Khan.	35 Surveyors, &c.	
		No. 2 Party ...	Baluchistán ...	Major F. W. Pirrie, I.A., Lieut. F. J. M. King, R.E., Lieut. C. M. Thompson, I.A.	Messrs. F. B. Powell, H. C. H. Cooper, Subadar Kanak Singh, Messrs. E. C. O'Sullivan, G. E. R. Cooper, F. Byrne.	Sher Jung, K.B., Lal Singh, R. B.	47 Surveyors, &c.	
		No. 3 Party ...	Punjab ...	Captain A. A. McHarg, R.E., Captain E. C. Baker, R.E.	Messrs. J. A. Freeman, B. M. Berrill, B. C. Newland, F. H. Grant, H. P. Butterfield, F. E. R. Calvert, Babu Jiya Lal.	Mhd. Lutf Ali ...	34 Surveyors, &c.	
		No. 4 Party (including Punjab Riverain Detachment)	Punjab ...	Captain L. C. Thuillier, I.A., Captain M. N. Macleod, R.E.	Messrs. G. J. S. Rae, H. W. Biggie, C. E. C. French, Maya Das Puri, A. B. Hunter, F. C. Pilcher, Abdul Aziz, M. H. T. Hughes.	Vidya Nath Suri	101 Surveyors, &c.	No. 1 Cantonment Section was absorbed in this party.
		No. 9 Party ...	Baluchistán ...	Major G. A. Beazeley, R.E., Lieut. C. M. Thompson, I.A.	Messrs. W. J. Newland, P. A. T. Kenny, H. C. Stotesbury, D. K. Rennick, J. McCracken, A. J. A. Drake, F. J. Grice.	Gopal Singh, R. B., Dalbir Rai.	49 Surveyors, &c.	*Temporarily in Northern Circle.*
		U. P. Drawing Office.	Mussooree ...	.....	Mr. J. M. Kennedy ...	M. Kennedy ...	18 Draftsmen, &c.	
		Simla Drawing Office.	Simla ...	Lieut. J. D. Campbell, R.E., Lieut. P. G. Huddleston, R.E.	Mr. H. T. Hughes ...	.....	12 Draftsmen, &c.	This office was placed under direct administrative control of the S. G. from 1st April 1910.
SOUTHERN.	Colonel T. F. B. Renny-Tailyour, R.E., up to 17th October 1909 and from 1st March 1910, Lieut.-Colonel J. M. Fleming, I.A., from 18th October, 1909 to 28th February 1910. *Superintendents, Southern Circle.*	Southern Circle Drawing Office.	Bangalore ...	.....	Messrs. A. Ewing, J. Smith ...	B. P. Muthanna, K. Mandanna.	13 Surveyors, &c.	
		No. 5 Party ...	Central Provinces	Major C. L. Robertson, C.M.G., R.E., Lieut. C. F. Nation, R.E.	Messrs. F. P. Walsh, W. Skilling, C. West, R. E. Saubolle, Babu Munshi Lal.	.....	38 Surveyors, &c	

Circle.	Administrative Officer.	Party or Office.	Locality.	Imperial Officers.	Provincial Officers.	Upper Subordinates.	Lower Subordinate Establishment.	REMARKS.
SOUTHERN.	Colonel T. F. B. Renny-Tailyour, R.E., up to 17th October 1909 and from 1st March 1910, Lieut.-Colonel [redacted] M. Fleming, I.A., from 18th October 1909 to 28th February 1910, *Superintendents, Southern Circle.*	No. 6 Party ...	Bombay and Berár.	Captain H. L. Crosthwait, R.E., Captain H. Wood, R.E., Lieut. S. W. S. Hamilton, R.E., Lieut. K. W. Pye, R.E., Lieut. J. A. Field, R.E.	Messrs. A. Ewing, C. G. Lee, Amar Sing, J. H. S. Wilson, P. R. Anderson, J. R. Newland, E. A. Meyer, A. K. Mitra, F. B. Kitchen, C. O. Picard, P. C. Mitra, F. C. Saint, E. J. Hanby, R. B. Gildea, C. B. Sexton, A. J. Booth, R. M. Wyatt.	R. V. Joshi, Dharma.	68 Surveyors, &c.	Old Nos. 2 & 17 Parties amalgamated to form this party on 1st March 1910.
		No. 7 Party ...	Madras, Mysore and Coorg.	Capt. C. P. Gunter, R.E., Lieut. S. W. S. Hamilton, R.E., Lieut. A. H. Gwyn, I.A.	Messrs. R. Waller-Senior, W. M. Gorman, J. O'B. Donaghey, W. E. S. Swiney, H. D. W. Stotesbury, J. C. Pollett.	Eknath Battu, Abdul Hakk.	28 Surveyors, &c.	The former Coorg detachment was absorbed in this party.
		No. 8 Party ...	Madras ...	Capt. C. M. Browne, D. S. O., R.E., Lieut. S. W. S. Hamilton, R.E., Lieut. C. G. Lewis, R.E.	Messrs. J. Smith, W. F. E. Adams, E. J. Biggie, S. F. Norman, M. Mahadeva Mudaliar, Balaji Dhondiba, M. S. Ganesa Aiyar, A. J. Fraser.	Anantarao Dhondiba.	30 Surveyors, &c.	
EASTERN.	Lieut.-Col. P. J. Gordon, I.A., *Superintendent, Eastern Circle.*	Eastern Circle Drawing Office. *No. 9 Party temporarily in Northern Circle.*	Bangalore ...	.....	Messrs. H. C. H. Cooper, *T. Shaw* (re-employed).	B. C. H. Collins, Raghubar Datt Thuplyal, Matindra Ranjan Mazumdar, Balmokand.	42 Draftsmen, &c.	
		No. 10 Party ...	Northern Shan States.	Capt. L. G. Crosthwait, I.A.	Messrs. O. D. Smart, F. S. Bell, C. S. Littlewood, W. C. Jarbo, E. Claudius, Asmat-Ullah Khan, E. M. Kenny, Abdul Rahim, K.S., W. H. Strong.	Lachman Daji Judu, R.S.	37 Surveyors, &c.	Including No. 2 Cantonment Section absorbed in this party and a Land Records Training Section.
		No. 11 Party ...	Northern Shan States.	Capt. R. H. Phillimore, R.E., Capt. E. C. Baker, R.E.	Messrs. Jagdamba Prasad, S. S. M. Fielding, V. W. Morton, T. P. Dewar, A. A. Graham, J. G. Vander-Beck, H. St. J. Kenny.	Hayat Muhammad.	23 Surveyors, &c.	
		No. 12 Party ...	Eastern Bengal and Assam.	Major A. Mears, I.A., Lieut. G. F. T. Oakes, R.E.	Messrs. C. C. Byrne, Pramadaranjan Ray, J. H. Williams, Amjad Ali, L. Williams, J. O'C. Fitzpatrick.	.....	40 Surveyors, &c.	

Col. S. G. Burrard, R.E., F.R.S., *Superintendent, Trigonometrical Surveys.*	Trigonometrical Surveys Office.	Dehra Dún	J. Eccles, Esq., M.A., Lieut. F. B. Scott, I.A., Lieut. W. E. Perry, R.E., Lieut. C. F. Nation, R.E., Lieut. R. S. Wahab, I.A.	Messrs. J. P. Barker, J. H. Nicol, Aulad Hossein, O. C. Ollenbach, Moqimuddin, A. J. Moore, H. H. Creed, J. A. Calvert.	Ram Singh, R. S., Karuna Kumar Das, B.A., Bidhu Bhusan Shome, Nanak Chand Puri, Ram Narain Hastir, Jugal Behari Lal.	Special establishment.
	No. 13 Party (Astronomical Latitudes).	Oudh ...	Capt. H. J. Couchman, R.E., Major H. L. Crosthwait, R.E.	Mr. R. Waller-Senior ...	.....	2 Computers, &c.
	No. 14 Party (Pendulum Operations).	Central Provinces.	Capt. H. M'C. Cowie, R.E.	Mr. Hanuman Prasad ...	.....	3 Computers, &c.
	No. 15 Party (Triangulation).	Northern Baluchistán, Kashmír, Upper Burma.	Capt. C. M. Browne, D.S.O., R.E., Major H. H. Turner, R.E., J. deG. Hunter, Esq., M.A., Lieut. E. B. Cardew, R.E., Lieut. F. J. M. King, R.E., Lieut. H. G. Bell, R.E., Lieut. K. Mason, R.E.	Messrs. H. B. Simons, C. H. Tresham, Abdul Hai, V. D. B. Collins, F. W. Smith, G. A. Norman, B. T. Wyatt, Abdul Karim, K. S. Gopalachari, Mohan Lal Arora, V. P. Wainwright, C. S. McInnes.	..	19 Computers, &c.
	No. 16 Party (Tidal Operations).	Indian Ports	C. F. Erskine, Esq.	Mr. H. G. Shaw, Syed Zille Hasnain	.....	21 Computers, &c.
	No. 17 Party (Levelling).	Burma, Bengal and U. P., Punjab, Sind and Central India.	C. F. Erskine, Esq., Major J. M. Burn, R.E.	Messrs. E. H. Corridon, A. M. Talati, O. N. Pushong, D. H. Luxa, T. F. Kitchen, H. St. J. Kenny, O. D. Jackson.	.....	9 Recorders, &c.
	No. 18 Party (Magnetic Survey).	India ...	Capt. R. H. Thomas, R.E., Capt. H. J. Couchman, R.E., Lieut. H. T. Morshead, R.E.	Messrs. E. C. J. Bond, H. P. D. Morton, R. P. Ray, N. R. Mazumdar, R. B. Mathur.	.....	19 Recorders, &c.
	Forest Map Office.	Dehra Dún ...	Major J. M. Burn, R.E.	*Mr. A. Desculs*, (re-employed). ...	.....	....

PART II.

SURVEY WORK IN THE FIELD.

I.—TOPOGRAPHICAL SURVEYS.

NORTHERN CIRCLE (*vide* index map p. 11).

No. 1 (late 14) Party.—No. 1 Party surveyed an area of 5,100 square miles in the Abbottábád district of the North-West Frontier Province, in the Ráwalpindi, Jhelum, Gujrát and Sháhpur districts of the Punjab and in the Púnch district of Kashmír. The country surveyed was of a varied nature and included the level plains of Gujrát and Sháhpur, the broken and intersected country of Ráwalpindi and Jhelum, the Murree hills and the slopes of the Pir Panjál range of Kashmír.

No. 3 (late 12) Party.—No. 3 Party surveyed an area of 3,235 square miles, in the Jhang, Sháhpur, Lyallpur and Miánwáli districts of the Punjab and ran 337 linear miles of levelling. The country surveyed lay mostly in the Jhelum and Chenáb Canal colonies and was flat and open.

No. 4 (late 18) Party.—No. 4 Party surveyed an area 3,314 square miles in the Miánwáli, Attock and Sháhpur districts of the Punjab, triangulated 1,250 square miles, chiefly in the Salt Range, and completed 492 linear miles of traversing in the Sháhpur district, while a special detachment traversed an area of 6,000 square miles in the Lucknow, Unao, Hardoi, Sítápur, Bára Banki and Ráe Bareli districts of the United Provinces to form the basis for topographical survey which will be carried out by this party during 1910-11. The country surveyed was varied, lying partly in flat and cultivated plains, partly in the broken slopes of the Salt Range and partly in the *Thal* desert.

No. 1 Cantonment Section, which was absorbed by No. 4 Party during the year, surveyed three cantonments, namely Lucknow, Meerut and Dharmsála, and submitted maps of the following eight for publication: (*i*) the seven "Galis" (Baragali, Kálábágh, Ghora Dhaka and Khanaspur, Changlagali, Khayragali and Barian) (*ii*) Jalápáhár (*iii*) Attock and Thandi Bir (*iv*) Jhelum (*v*) Fort William (*vi*) Dharmsála (*vii*) Ichhápur (*viii*) Shillong.

The Punjab Riverain Detachment which was separated from No. 4 Party on the 1st of July 1910, continued its work of traversing and laying down base lines for the future demarcation and survey of riverain boundaries, and for the general co-ordination of the cadastral surveys of the Punjab Government. 637 linear miles of main traverse and 1,650 miles of minor traverse were completed along the banks of the rivers Sutlej, Beás and Rávi and 247 base lines were laid down with permanent márk stones. 1,587 village plots of 201 villages were completed during the year and supplied to the Punjab Settlement department, and twenty sheets on the 4-inch scale were compiled.

SOUTHERN CIRCLE (*vide* index map p. 11).

No. 5 (late 1) Party.—No. 5 Party surveyed an area of 2,291 square miles in the Jubbulpore, Damoh and Mandla districts of the Central Provinces and in Rewah State, and triangulated 2,278 square miles in the Hoshangábád district and in Bhopál State. The country surveyed was for the most part hilly and wooded. The recess Headquarters of the party were transferred from Poona to Bangalore during the year.

No. 6 Party.—Old Nos. 2 and 17 Parties were amalgamated to form this party on 1st April 1910. The areas surveyed by the combined parties amounted to 4,982 square miles in Nágpur, Wardha and Chánda districts of the Central Provinces, in the Nánder, Sirpur Tándúr and Aurangábád districts of Hyderábád, in the Yeotmál and Buldána districts of Berár, in the East Khándesh district of Bombay and in Indore State. 5,032 square miles were triangulated and 788 linear miles of traversing for forest boundaries were completed in the same localities.

Heavily wooded, rugged hills with little water and few communications marked the country surveyed along the boundary between Indore and East Khándesh and in a small area of the Central Provinces, but otherwise the land, though containing numerous forest reserves, was fairly open and easy to survey.

No. 7 (late 3) Party.—Working for the first time in Southern India, No. 7 Party surveyed an area of 2,164 square miles and triangulated 1,850 square miles in the South Kanara and Malabar districts of Madras and in Mysore and Coorg.

The country varied exceedingly in character, extending from the low Malabar coast land over the Western Ghats and wooded hills of Coorg into the great plateau of Mysore, and was on the whole difficult to work in.

No. 8 (late 19) Party.—No. 8 Party surveyed an area of 3,095 square miles and completed 900 square miles of triangulation and 312 linear miles of traversing in Travancore and Cochin States and in the Nílgiri, Coimbatore, Malabar and Tinnevelly districts of Madras. The Nílgiris and hilly portions of Malabar, Coimbatore and Cochin are covered with comparatively open jungle on the lower ground, giving way to dense, moist, evergreen forest on the upper slopes, until the high plateaux consisting of undulating open downs with clear streams of running water are reached at an elevation of about 6,000 feet. The plains of the west coast consist of paddy fields surrounded by dense groves of palms which render survey work difficult and slow.

EASTERN CIRCLE (*vide* Index map p. 11).

No. 10 Party.—No. 10 Party surveyed an area 3,516 square miles in the Northern Shan States of Möngmit and North Hsenwi including 150 miles of the Burma-Yünnan frontier, and 592 square miles of country beyond the frontier were sketched in. 4,415 square miles were triangulated and 263 linear miles of traverse were completed in the Katha, Bhamo and Myitkyina districts of Upper Burma.

The country lay at a high altitude and consisted chiefly of high, sparsely wooded hills and grassy uplands in which survey was easy.

No. 2 Cantonment Section was absorbed by this party during the year and completed the survey of the Bhamo, Mandalay, Maymyo and Meiktila cantonments, while that of Rangoon was commenced, the total area amounting to 15,545 acres. 81 sheets of the maps of the Secunderábád and Bolárum Bazars surveyed in previous seasons were submitted for publication.

No. 10 Party also maintained a section for the purpose of giving practical training in cadastral survey to probationers of the Burma Land Records department who had already gone through a preliminary course of instruction at Dehra Dún. The course lasted twelve months, during which the pupils carried out traversing, 16-inch cadastral survey, 64-inch town survey and the computations, mapping and area calculations connected therewith.

No. 11 Party.—No. 11 Party surveyed an area of 3,997 square miles in the portions of the Shan States of North Hsenwi, South Hsenwi, Manglön and Kèng Tung lying in the vicinity of the Salween river and bounded on the east by Yünnan and the Wa States. Triangulation was completed over an area of 3,050 square miles in Mawkmai and Möngpan States and in Karenni.

The country was similar to that surveyed by No. 10 Party, consisting of bold, lightly wooded hills.

No. 12 (late 20) Party.—No. 12 Party Surveyed an area of 2,223 square miles in the Sylhet, Lushai Hills, Cáchár and Khási and Jaintia Hills districts of Eastern Bengal and Assam and in Hill Tippera State, and completed an area of 2,005 square miles of triangulation and 271 linear miles of traversing in the same locality. The country varied from the open cultivated plains of Sylhet to the mountainous country of the Lushai Hills and Hill Tippera, covered with the densest bamboo and evergreen forests.

The recess headquarters were transferred from Bangalore to Shillong during the year.

TOPOGRAPHICAL SURVEYS.

Table shewing Outturns and Costs.

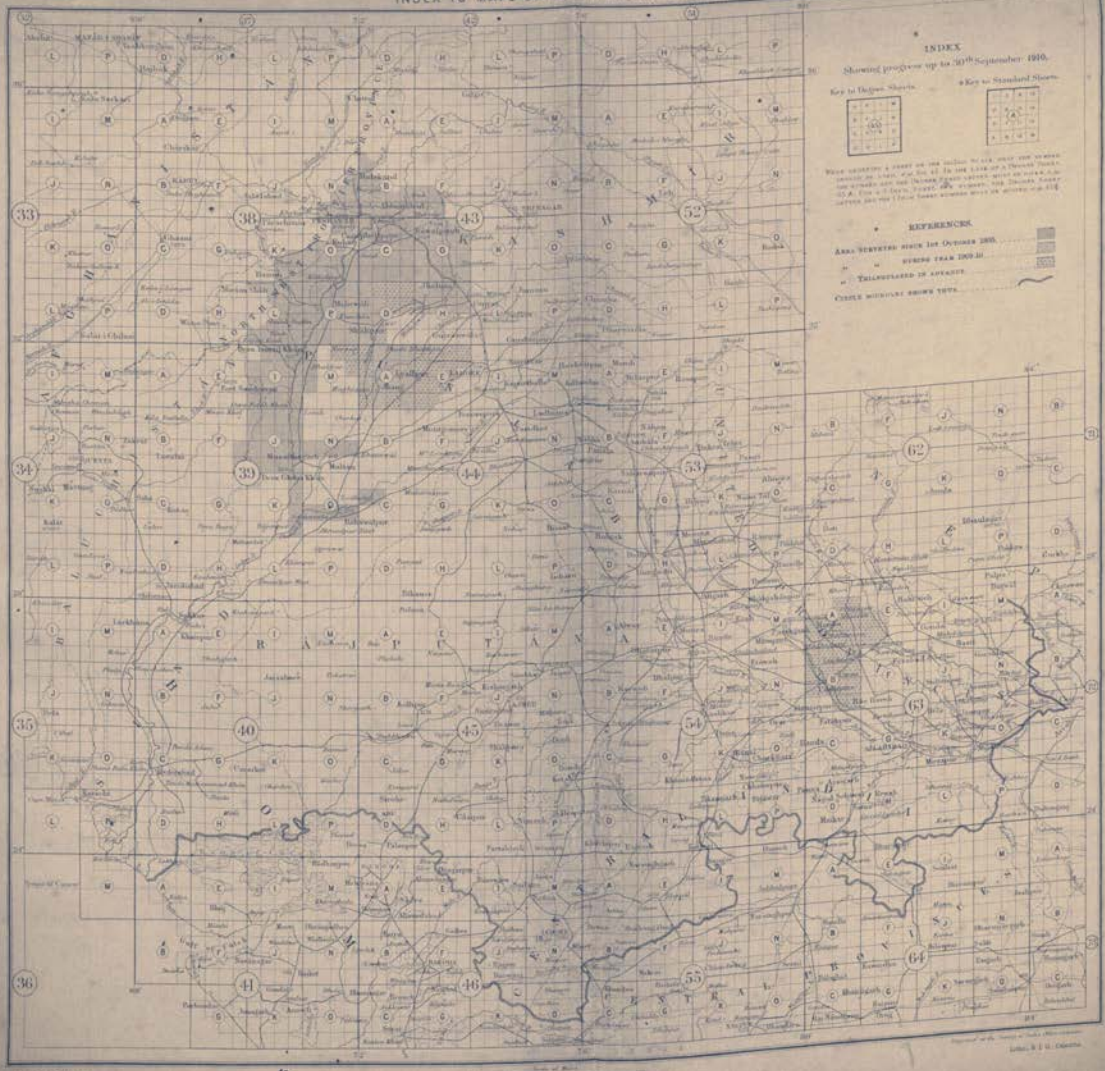
1909-1910.

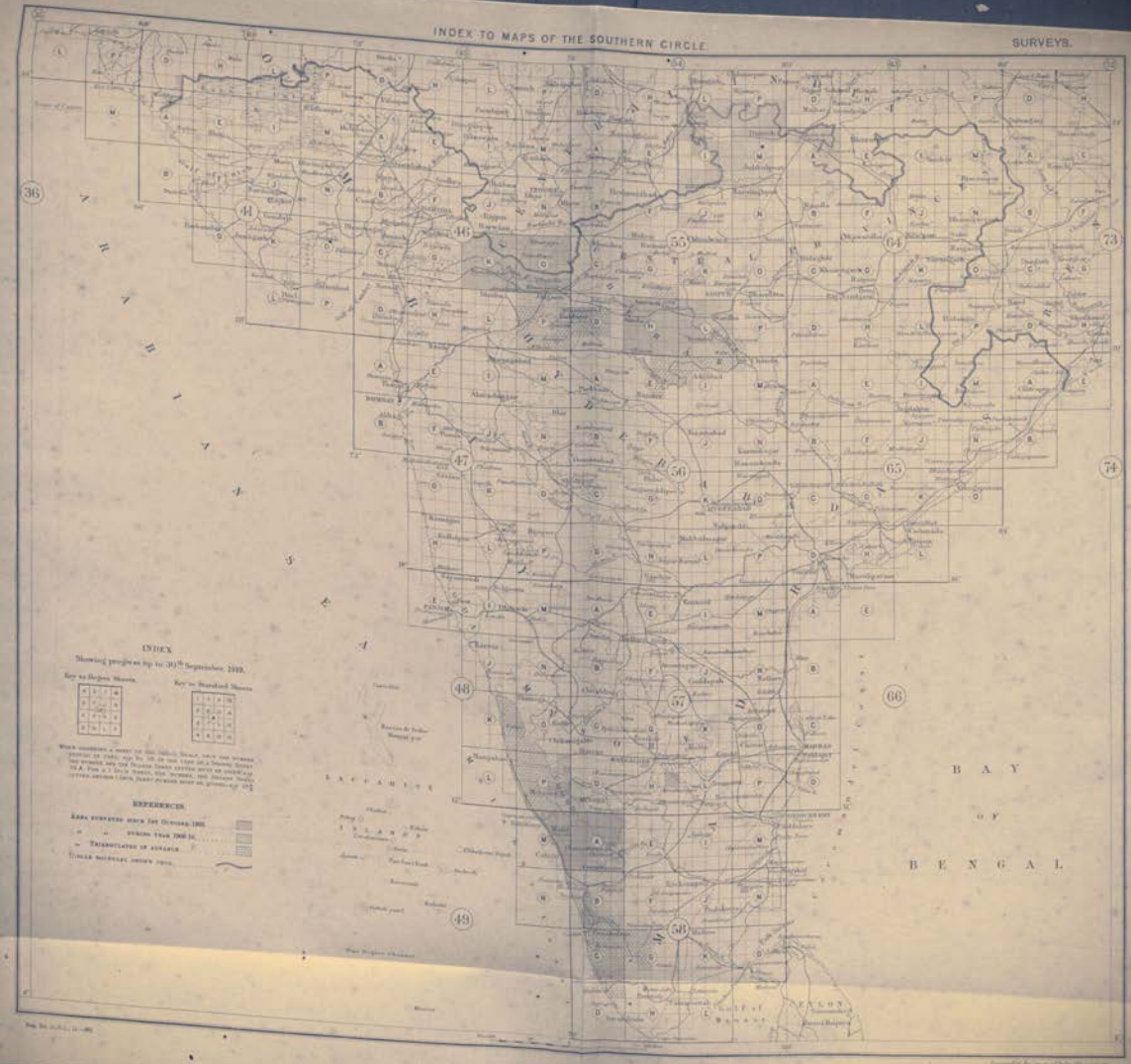
2	3	4	5	6	7	8	9	10	11	12	13
Circle.	Party.	Locality.	Character of Ground.	Type of Survey.	Scale.	Outturns.		Total Outturn of Survey on all scales.	Difference from 6,000 square miles per party.*	Total cost.	Cost rate per square mile Survey and Mapping.	Remarks.
						Survey.	Mapping.					
						Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Rs.*	*Rs.*	
N.	No. 1	N. W. F. Province, Punjab, and Kashmir	Open, hilly in parts ...	Resurvey ...	1 inch	5,100	3,570	5,100	—900	1,00,951	19·8	
N.	No. 3	Punjab ...	Flat, intersected by canals partly wooded.	Survey ...	1 inch	3,235	3,235	3,235	—2,765	76,928	23·8	
N.	No. 4	Punjab ...	Flat open, partly desert	Survey ...	1 inch	1,762	3,163	3,314	—2,686	†98,694	29·7	†Excluding Rs. 35,356 on local surveys.
			Hilly and intricate ...	Survey ...	2 inch	1,552						
			Totals, Northern Circle ...	.....	...	....	9,968	11,649	—6,351	2,76,573	23·7	
S.	No. 5	Central Provinces ...	Hilly and wooded ...	Survey ...	1½ inch	528	1,460	2,291	—3,709	91,086	39·8	
			Hilly and wooded ...	Survey ...	1 inch	1,763						
S.	No. 6	Bombay and Berár	Part open, part hilly and wooded.	Survey ...	1 inch	3,078	4,733	4,982	—1,018	1,74,999	35·1	
				Resurvey ...	1 inch	1,564						
			Forest, hilly and intricate	Survey ...	2 inch	78						
				Resurvey ...	2 inch	262						
S.	No. 7	Madras, Mysore, and Coorg.	Varied ...	Survey ...	1 inch	876	2,031	2,164	—3,836	97,032	44·9	
			Open ...	Resurvey ...	1 inch	875						
			Dense forest ...	Survey ...	2 inch	413						
S.	No. 8	Madras ...	Part open, part forest ...	Survey ...	1 inch	2,396	1,905	3,095	—2,905	94,378	30·5	
			Flat enclosed ...	Supplementary Survey.	1 inch	190						
			Forest, dense and open ...	Survey ...	2 inch	509						
			Totals, Southern Circle ...	.....	...	....	10,129	12,532	—11,468	4,57,495	36·5	
E.	No. 10	Northern Shan States	Bold, lightly wooded hills	Survey ...	1 inch	3,305	3,000	3,516	—2,184	†1,33,860	38·1	†Excluding Rs. 43,131 on local surveys.
E.	No. 11	Northern Shan States		Resurvey ...	1 inch	211						
				Survey ...	1 inch	3,997	3,000	3,997	—2,003	1,41,726	35·5	
E.	No. 12	Eastern Bengal and Assam.	Open cultivated plains and wooded hills.	Survey ...	1 inch	1,060	2,223	2,223	—3,777	1,38,934	62·5	
				Resurvey ...	1 inch	322						
				Supplementary Survey.	1 inch	420						
			Dense forest ...	Survey ...	2 inch	421						
			Totals, Eastern Circle ...	... ...	...	.....	8,223	9,736	—8,264	4,14,520	42·6	
			Grand Totals ...	.....	...	...	28,120	33,917	—26,083	11,48,588	33·9	

* The figure 6,000 square miles from which differences are shewn in column 10 is the *full* annual outturn per party, which it is hoped may be attained in future.

In order to reduce expenditure the programmes and establishments of topographical parties were cut down soon after the commencement of the field season, 1909-1910. This has adversely affected outturns and costs

INDEX TO MAPS OF THE NORTHERN CIRCLE.

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Showing progress up to 30th September 1910.
Key to Degree Sheets.
Key to Standard Sheets
REFERENCES.
Land surveyed since 1st October 1905
" " during Year 1909-10.
" Triangulation in advance
Under Survey during 1910.
INDIA
BAY OF BENGAL
CEYLON
Gulf of Manaar
LACCADIVE ISLANDS
Minicoy
Suadiva
Addoo
Kolumadulu
Nilandu
Kardiva
Kalpeni
Kadmat
Kiltan
Chetlat
Bitra
Amini
Kavaratti
Agatti
Andrott
Malabar Coast
Mangalore
Cannanore
Tellicherry
Calicut
Beypore
Ponnani
Cochin
Alleppey
Quilon
Trivandrum
Cape Comorin
Pamban
Rameswaram
Mannar
Jaffna
Point Pedro
Trincomalee
Batticaloa
Hambantota
Galle
Colombo
Kalutara
Negombo
Puttalam
Kalpitiya
Chilaw
Kankesanturai
Talaimannar
Adam's Bridge
Palk Strait
Pamban Channel
Vaigai R.
Cauvery R.
Kaveri R.
Pennar R.
Krishna R.
Godavari R.
Mahanadi R.
Vaigai
Tambraparni R.
Periyar R.
Bharathapuzha R.
Ponnani R.
Chaliyar R.
Kadalundi R.
Kallayi R.
Valapattanam R.
Nileshwar R.
Mangalore
Kundapur
Honavar
Karwar
Goa
Vingorla
Ratnagiri
Dabhol
Chiplun
Bombay
Surat
Broach
Cambay
Gulf of Cambay
Diu
Porbandar
Veraval
Mangrol
Jafarabad
Dwarka
Okha
Gulf of Kutch
Kandla
Mandvi
Mundra
Jakhau
Lakhpat
Sindh
Karachi
Kotri
Hyderabad
Mirpur Khas
Nawabshah
Sukkur
Rohri
Jacobabad
Shikarpur
Larkana
Dadu
Jhimpir
Keti Bandar
Shah Bandar
Gharo
Thatta
Kharak
Jati
Sonmiani
Pasni
Gwadar
Jiwani
Ormara
Las Bela
Kalat
Quetta
Chaman
Kandahar
Afghanistan
Persia
Baluchistan
Makran
Sarawan
Jhalawan
Kachhi
Sibi
Bolan Pass
Nushki
Nasirabad
Jacobabad
Shikarpur
Sukkur
Rohri
Khairpur
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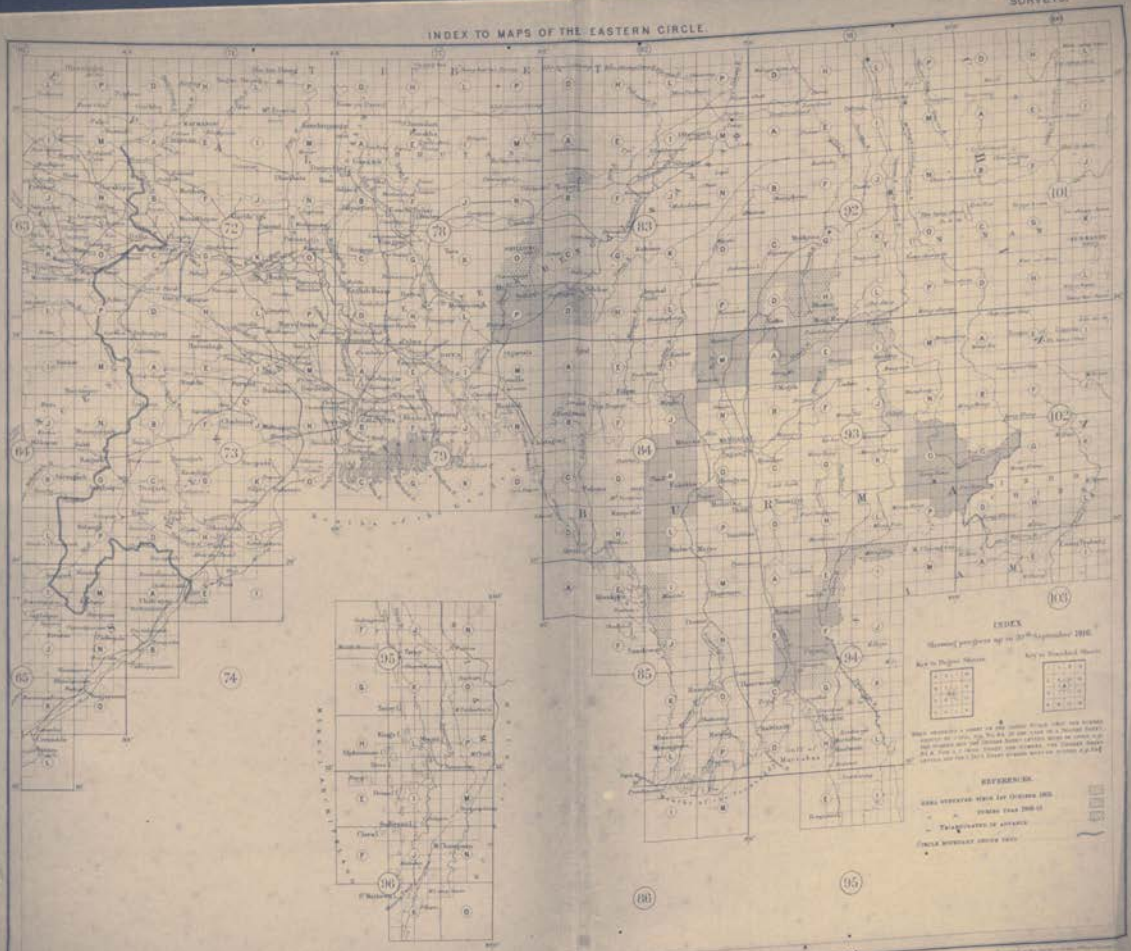


Table shewing progress of Topographical Surveys, 1905 to 1910.

Outturns in square miles.

Survey year.	Scale.	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1905-06 ...	1 inch and 2 inch	5,995	1,660	10,322	17,977
1906-07 ...	do.	7,277	7,666	8,659	23,602
1907-08 ...	do.	14,530	9,256	12,431	36,217
1908-09 ...	do.	17,957	12,526	11,542	42,025
1909-10 ...	do.	23,833	12,532	9,736	46,101
Areas completed to date ...	do.	69,592	43,610	52,690	165,922
Total areas included in the topographical programme.	1 inch	620,000	542,800	528,800	1,691,600
	½ inch	130,000	.....	.....	130,000
Approximate areas remaining for Survey.	1 inch	550,408	499,160	476,110	1,525,678
	½ inch	130,000	.....	.....	130,000

II.—FOREST SURVEYS.

The forest surveys of the year were carried out, in almost every case, by the particular topographical parties in whose spheres of operations the forests lay. The surveys were for the most part on the 2-inch scale, but some were on the 1-inch scale; forest boundary surveys on the 4-inch scale were carried over a considerable area. The revision of certain areas previously surveyed on the 4-inch scale by the old Forest Survey Branch was also effected.

Northern Circle.

Punjab.—The forest areas, surveyed by No. 4 (late 18) Party on the 2-inch scale, fell chiefly in the Salt and Khushâb ranges of the Shâhpur district, with some small areas in the Miânwâli and Attock districts of the Shâhpur Forest division; the boundaries of most of those falling in the Salt range had been previously surveyed by the Forest Survey Branch on the 4-inch scale. The total area of forests thus surveyed in the Shâhpur district amounted to 343 square miles and in the Miânwâli and Attock districts to about 4 square miles, or a total of about 347 square miles of the Shâhpur Forest division. In addition to these an area of about 34 square miles was surveyed in the Jhelum Forest division (Attock district) on the 2-inch scale and a few forests lying in the *Thal* desert on the 1-inch scale.

Southern Circle.

Central Provinces. (*Berâr Circle*).—In the course of the topographical survey of Berâr, No. 6 (late 2) Party surveyed on the 2-inch scale all the A, B and C class forests falling in the area under survey in the Yeotmâl district, and their boundaries were rigorously traversed by theodolite and plotted on the 4-inch scale. The area surveyed on the 2-inch scale amounted to 78 square miles and the boundary traversing to 229 linear miles. In addition to these, about 191 linear miles of the boundaries of the A and B class forests lying in the area proposed for detail survey next working season were traversed in advance. C class forests were not specially surveyed before, and considerable difficulties were experienced in identifying their boundaries as the field boundary marks were in many places found missing. In two cases it was absolutely impossible to survey the boundary, as no marks of any kind existed on the ground. Steps have, however, been taken to inspect the boundary marks and renew them if found missing, and it is hoped that in the ensuing year there will be no further difficulties over this question.

Madras Presidency.—Forest Surveys on the 2-inch scale were carried on during the year by Nos. 7 and 8 (late 3 and 19) Parties in the following Divisions:—

In the Nîlgiris 122 reserved forests of a total area of 59 square miles were surveyed. Of these 37 forests were partially done last year. In addition to this many corrections to the demarcated boundaries were entered on last year's plane-table sections. The survey of the reserved forests in the Nîlgiris is now complete. In Central Coimbatore there were surveyed the Attapâdi forest reserve which has recently been transferred to this division from South Malabar, and the Chenat Nair, Pulampara and Varalapadi forest reserves, comprising an area of 48 square miles. In South Coimbatore the greater part of the Anamalai forest reserve falling in sheet 58 $\frac{B}{15}$ was resurveyed on the 2-inch scale, as the old 4-inch maps were found to be extremely inaccurate. The area thus surveyed amounted to 131 square miles. In South Kanara, Sampaje, Todikana, Kiribagh, Nalkuru and Devachalla forest reserves, of a total area of 40 square miles, were surveyed. The only forest reserve which had not been previously traversed by theodolite (with the exception of the Nîlgiris reserves) was the Attapâdi forest, Block No. VI; it was intended to traverse this, but the boundary was not cleared in time for the traverse to be carried out, and it was abandoned. The total area surveyed in the Madras Presidency amounted to 278 square miles.

Bombay Presidency.—The survey of the Sátpura reserve on the 2-inch scale which was commenced in the year 1905-06 was completed this year by No. 6 Party, and about 121 square miles were surveyed. In addition to this about 114 square miles of forests in the Bhusáwal, Jámner and Jálgaon talukas of the East Khándesh district were surveyed on the same scale. Boundary surveys of all these forests, amounting to 316 linear miles, were made on the 4-inch scale.

Coorg.—In Coorg, 20 reserved forests, of a total area of 309 square miles, were surveyed by No. 7 Party on the 2-inch scale.

Eastern Circle.

Eastern Bengal and Assam.—The survey of the Katakhal and Sonai reserves in the Cáchár Forest division, which was commenced last year, was completed on the 2-inch scale by No. 12 (late 20) Party, and the Inner Line and Barail reserves have been mapped up to the limits of the topographical programme of the party. The officer in charge reports that the large area of dense bamboo and cane jungle, the impenetrable nature of the undergrowth and extensive swamps met with in parts, made the survey of the Cáchár forests one of the most trying and difficult pieces of work that have so far been experienced by his party, either in Burma or Assam. The area thus surveyed in the Cáchár division amounted to 293 square miles. The Langai and Shingla reserves in the Sylhet Forest division, comprising an area of 94 square miles, came under survey and were completed.

III.—TRIGONOMETRICAL SURVEYS.

TRIANGULATION (*vide* index map p. 18).

The work of No. 15 Party included principal, secondary and tertiary triangulation.

(a). Principal Triangulation.

(*i*).—The North Baluchistán series emanating from the side Zawa-Zibra of the Kalát longitudinal series was extended through the whole length of Northern Baluchistán and closed on the side Tounsa-Langawala of the Great Indus series.

The following is an abstract of the work done:—

Number of Principal Stations observed at	...	...	17
Number of Principal Stations newly fixed	...	...	15
Number of Principal Stations built	...	...	5
Length of triangulation completed in miles	...	...	261
Area of triangulation in square miles	...	...	6,580
Average triangular error of 24 triangles	...	...	0″·303
Number of Astronomical Azimuths observed	...	...	3

(*ii*).—The Kashmír series emanating from the side Nerh-Khagriána of the North-West Himalaya series was continued to latitude 34°-50′ N.

The following is an abstract of the work done:—

Number of Principal Stations observed at	...	...	9
Number of Principal Stations newly fixed	...	...	7
Number of Principal Stations built	...	...	11
Length of triangulation completed in miles	...	...	90
Area of triangulation in square miles	...	...	1,600
Average triangular error of 7 triangles	...	...	0″·591
Astronomical azimuth observed	...	...	1

In addition to triangulation work, a series of comparisons was carried out to test the accuracy of mercurial barometers, aneroid barometers and hypsometers, as height measuring instruments.

The results proved that the aneroid barometers differed greatly from one another and from the mercurial barometers. The latter gave heights in defect, and the hypsometers gave heights considerably in excess of those obtained by triangulation. At 16,000 feet the excess was as much as 600 feet.

The constants employed in the formulæ by which elevations are deduced from barometric and hypsometric observations require modification.

(*iii*).—The Upper Irrawaddy series was commenced from the side Taugte-Lakar Bum of the Great Salween series.

The following is an abstract of the work done:—

Number of Principal Stations observed at	...	...	9
Number of Principal Stations newly fixed	...	...	4
Number of Principal Stations provisionally fixed		...	3
Number of secondary Stations provisionally fixed		...	3
Length of triangulation completed in miles	...	...	112
Area of triangulation in square miles	...	...	2,900
Average triangular error of 8 triangles	...	...	0″·381
Astronomical Azimuth observed	...	...	1

(b).—Secondary Triangulation.

Two secondary series, the Mawkmai and Khási Hills series, were commenced in Upper Burma and Assam respectively. The work done is shewn in the following abstracts.

The Mawkmai Series.—

Stations observed at	31
Stations fixed	36
Stations built	16
Length of triangulation completed in miles	140
Area of triangulation in square miles	1,810
Average triangular error of 25 triangles	1″·99

The Khási Hills Series.—

Stations observed at	12
Stations fixed	10
Stations built	24
Length of triangulation completed in miles	41
Area of triangulation in square miles	400
Average triangular error of 10 triangles	3″·17

(c).—Tertiary Triangulation.

Tertiary triangulation for the topographical survey of Kashmír was completed in sheets 43 $\frac{F}{11, 12, 15, 16}$ and 43 $\frac{J}{1}$ and commenced in sheets 43 $\frac{J}{3, 7, 8, 12, 16}$.

LEVELLING OPERATIONS.

No. 17 Party.—Three detachments were employed on levelling operations during the past season.

No. 1 levelling detachment carried out revision levelling from Rangoon to Pyinmana and new levelling from Wuntho to Myitkyina, and also connected the standard bench-marks at Rangoon, Pegu, Toungoo, Mandalay, Shwebo, Meiktila, Magwe, Wuntho and Myitkyina. The outturn amounted to 465 miles.

No. 2 levelling detachment levelled the Himalayan lines from Hardwár to Lansdowne, from Bareilly *viá* Káthgodám to Naini Tál (Brewery), and from Siliguri to Tindhária, and connected the standard bench-marks at Lucknow, Patna (Bankipore), Muzaffarpur, Motíhári, Bhágalpur, Purnea, Dinájpur, Burdwán, Calcutta, Balasore, Cuttack, Berhampur (Madras), Vizagapatam, Cocanáda, Bezwáda, Nellore and Rewah. The outturn was 310 miles.

No. 3 levelling detachment was employed on levelling from Laluwali G. T. S. *viá* Khánpur to Rohri, from Shikárpur to Jacobábád, from Páli *h.s.* to Godhra, and from Lahore to Dharmkot in the Himalayas, *viá* Pathánkot and Dharmsála; it also connected the standard bench-marks at Sadikganj, Baháwalpur, Khánpur, Sukkur, Jacobábád, Hyderábád (Sind), Karáchi, Godhra, Baroda, Rájkot, Surat, Dhúlia, Mhow and Bhopál (2). The outturn amounted to 501 miles.

During the past year a scheme for increasing the number of bench-marks fixed on ground rock was introduced; 150 rock-cut bench-marks were laid down and connected by the levelling officers in the course of their operations, and of these 49 bench-marks were protected by pillars of an approved design.

30 Standard bench-marks were erected and 41 connected during the year.

GEODETIC SURVEY.

(a).—Astronomical Latitudes.

No. 13 Party.—No. 13 Party was employed on latitude operations in Oudh. Of the 11 stations visited 5 were situated on that portion of the Karara Meridional series which lies north of the Ganges and the remainder were on the North East Longitudinal series.

The results of the season's work are given in the following table:—

Name of Station.	Latitude.	Longitude.	Height above mean sea level.	Deflection of the plumb-line (O−C)
	° ′	° ′	*feet*	″
Sora	26 17	81 12	400	+7·56
Pariaon	25 50	81 22	346	+8·33
Parewa	26 38	81 12	380	+7·44
Utiamao	27 0	81 12	386	+4·54
Imlia	27 19	81 8	428	−1·07
Masi	27 38	81 23	406	−10·38
Dadaura	27 43	81 43	420	−14·82
Mánichauk	27 37	82 5	360	−19·23
Basadela	27 24	82 17	366	−12·53
Pathardi	27 26	82 45	320	−18·66
Ghaus	27 21	83 6	296	−16·74

An attempt was made during recess to apply to India the method which Mr. J. Hayford has used in the United States, to ascertain whether the condition known as isostasy exists. This involved the computation of the deflection of the plumb-line, due to visible masses, up to a distance of 2,534 miles from each station. The deflection was computed for 106 latitude stations and for 18 longitude stations in the prime vertical.

(b).—Pendulum Operations.

No. 14 Party.—No. 14 Party carried out pendulum operations in a tract situated between Latitudes 21° and 26° N. and Longitudes 79° and 83° E., thus extending to the east and north-east the investigations commenced in the season 1908-09 in Central India.

In the table below are shewn the stations visited and the results obtained. The usual procedure was followed in carrying out the observations, four pendulums being swung at each place, and as a rule four complete sets of night and day observations made, each set being preceded and followed by star observations for the determination of clock rate.

TABLE.

No.	Stations.	Latitude.	Longitude.	Height.	g	g'	g_o''	γ_o	$g_o-\gamma_o$	$g_o-\gamma_n$
		° ′ ″	° ′	*feet.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
1	Rajpur ...	21 13 56	81 41	996	978·612	978·705	978·670	978·681	+0·024	−0·011
2	Amgáon ...	21 21 31	80 28	1,032	·614	·710	·674	·689	+0·021	−0·015
3	Bilaspur ...	22 3 53	82 12	878	·641	·763	·733	·733	+0·030	0·000
4	Seoni ...	22 5 29	77 29	2,032	·622	·811	·744	·735	+0·076	+0·009
5	Pendra ...	22 46 41	82 0	1,996	·638	·824	·754	·778	+0·046	−0·024
6	Jubbulpore ...	23 8 54	79 59	1,467	·719	·856	·806	·803	+0·053	+0·003
7	Umaria ...	23 31 37	80 54	1,499	·740	·880	·830	·827	+0·053	+0·003
8	Damoh ...	23 49 54	79 26	1,213	·758	·871	·829	·848	+0·023	−0·019
9	Katni ...	23 50 25	80 26	1,254	·757	·874	·830	·848	+0·026	−0·018
10	Saugor ...	23 51 47	78 48	1,757	·731	·895	·834	·850	+0·045	−0·016
11	Maihar ...	24 15 38	80 48	1,161	·784	·892	·851	·877	+0·015	−0·026
12	Allahábád ...	25 25 55	81 55	288	·943	·970	·972	·958	+0·012	+0·002

MAGNETIC SURVEY.

No. 18 Party.—Four detachments each under a Provincial officer were employed. Two of these re-observed at old field stations in the area lying between Latitude 16° to 19° and Longitude 73° to 78°, where the secular change in H. F. appeared to be abnormal. These detachments also surveyed a few small areas in detail. The third was employed on detail survey in Central India and the fourth took observations along the outer Himalaya from Naini Tal to Dharmsála.

The Imperial officers observed at all repeat stations with the exception of Port Blair and also at a number of old field stations. The four observatories were inspected and comparative observations taken at each, and also at Alibág.

In all 69 new stations of the preliminary survey and 71 of the detail survey were occupied, while 100 old field and 22 repeat stations were visited.

Work during recess.—The computation of the previous season's field work and the reduction and tabulation of the base station results for 1909 have been completed.

The mean values of the magnetic elements at the observatories in 1909 were as follows :—

Observatory.	Lat. N.	Long. E.	Declination.	Horizontal Force.	Vertical Force.	Dip.
	° ′	° ′	° ′	C. G. S.	C. G. S.	° ′
Dehra Dún ...	30 19	78 3	E. 2 34·8	·33276	·31909	43 48·0
Barrackpore ...	22 46	88 22	E. 1 0·7	·37300	·22099	30 38·7
Toungoo ...	18 56	96 27	E. 0 30·0	·38766	·16475	23 1·5
Kodaikánal ...	10 14	77 28	W. 0 50·1	·37459	·02391	3 39·1

TIDAL OPERATIONS.

No. 16 Party.—Observations were taken by means of self-registering tide-gauges during the year at the stations enumerated in the following list:—

	Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.		Remarks.
1	Aden ...	1879 ...	Still working	30		
2	Karáchi ...	* 1868 ...	* 1880	* 13	42	* Small tide-gauge working.
		1881 ...	Still working	29		
3	Bombay (Apollo Bandar) ...	1878 ...	,, ,,	32		
4	Bombay (Prince's Dock) ...	1888 ...	,, ,,	22		Property of Port Trust.
5	Madras ...	1880 ...	1890	10	25	
		Restarted ...	Still working	15		
		1895 ...				
6	Kidderpore ...	1881 ...	,, ,,	29		
7	Rangoon ...	1880 ...	,, ,,	30		
8	Port Blair ...	1880 ...	,, ,,	30		
9	Moulmein ...	1880 ...	1886	6	7	
		Restarted ...	Still working	1		
		1909 ...				

In addition to the above, readings to tide poles were taken at Bhávnagar, Chittagong and Akyab.

The nine tidal observatories at work were inspected during the year, and the registrations have been found satisfactory.

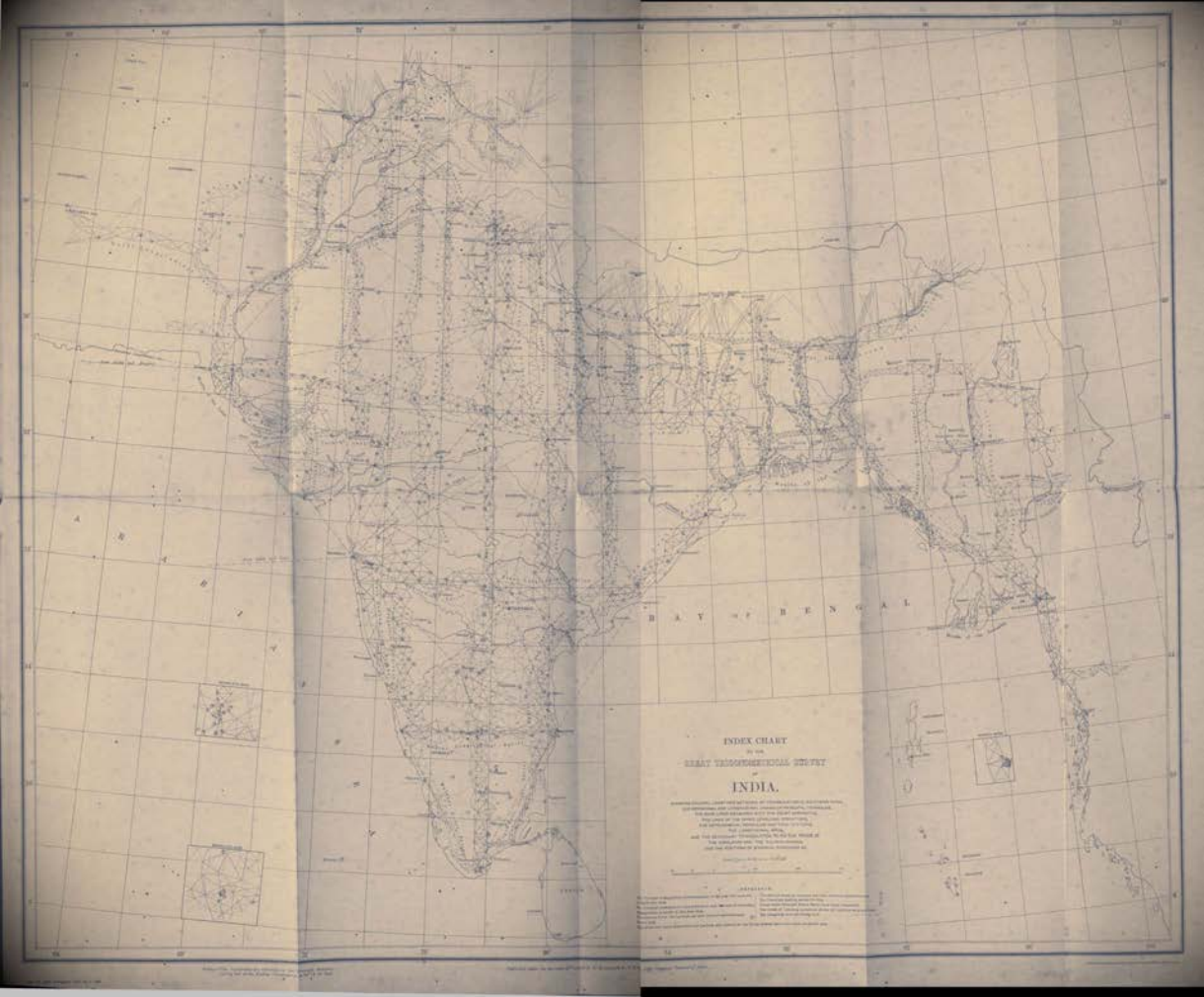
In the following tables are given the annual and decadal percentages of errors in the predicted times and heights of high and low waters at open coast and riverain stations.

Percentage of errors in Predicted Times and Heights at open coast stations from Automatic Registrations.

Year.	Number of Stations.	In Time.		In Height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1900	11	66	60	93	88	93	89
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
1905	7	82	79	96	95	96	97
1906	6	85	81	96	97	94	95
1907	6	84	83	98	98	98	99
1908	6	84	84	98	97	99	99
1909	6	85	86	97	97	97	98
Average of 10 years ...	...	80	75	96	95	96	95

Percentage of errors in Predicted Times and Heights at riverain stations from Automatic Registrations.

Year.	Number of Stations.	In Time.		In Height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
1905	2	52	62	72	57	94	92
1906	2	59	53	74	64	92	95
1907	2	58	47	78	60	96	90
1908	2	58	52	77	60	97	92
1909	3	61	59	69	65	93	92
Average of 10 years ...		57	58	73	60	93	91


BAY OF BENGAL
INDEX CHART
TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA.

PART III.

OFFICE WORK.

I.—HEADQUARTER OFFICES.

MAP PUBLICATION (*vide* index maps p. 27).

The maps, the publication of which forms the main task of the office, may be divided into four classes.

(*a*)—Small scale geographical maps.

(*b*)—Geographical maps on the one-millionth scale.

(*c*)—Degree sheets, *i.e.*, topographical maps on the scale of one inch to four miles, each sheet covering an area of one degree of latitude by one of longitude.

(*d*)—Standard sheets, *i.e.*, topographical maps on the scale of one inch to one mile, each sheet covering an area of 15 minutes by 15 minutes.

(*a*)—*Small scale geographical maps.*—During the year under report the new engraved map of India on the 32-mile scale has made fair progress. It has been decided to include Tibet in this map and to complete the north eastern sheet to its margins; this step will enhance the value of the map but will retard its completion.

A new series of engraved index maps on the 32-mile scale was commenced, each index embracing an area corresponding to that of one sheet on the one-millionth scale and giving full information with regard to the survey and publication of sheets of the "degree" and "standard sheet" series that fall within it.

(*b*)—*Geographical maps on the one-millionth scale.*—The compilation of these maps from such information as is available has gone on continuously in the Drawing Office. Two new sheets were published and many were carried to an advanced stage; it is hoped that of the fifty sheets covering India and Burma the greater part will shortly be printed. During the year nine sheets of this series were reprinted, and at its close eleven sheets were under publication.

(*c*)—*Degree sheets.*—The publication of this series of maps in colours in the same style as the one inch standard series has commenced. No degree sheet of India proper based on modern surveys was published during the year; nevertheless good progress has been made.

The question of hill shading for reproduction by the half-tone process has received much attention, and the experiments made have thrown light on the nature of the difficulties to be contended with and on the means of overcoming them.

Materials for the drawing of eighteen of the degree sheets of India proper and Burma, produced by the reduction of larger scale surveys, have been supplied to the circle drawing offices during the year.

(*d*).—*One-inch standard sheets.*—On 30th September 1909, 268 sheets of this series had been published and 84 were in course of publication. On 30th September 1910, 476 sheets had been published and 33 were under publication. During the year therefore 208 sheets were printed, as compared with 174 during 1908-09.

The figure 476 includes 127 sheets of which the drawing is based either on cadastral survey or on topographical survey executed prior to the 1st October 1905. Of these some have been printed in colours and some in black only; they have been published as preliminary editions and are not coloured on the index maps of this report.

The following table shows the progress made in the publication of one-inch standard sheets from new topographical surveys only, during the past 5 years; see index maps at the end of this report.

Year.	Standard Sheets Printed.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1905-06	0	0	0	0
1906-07	4	1	0	5
1907-08	16	11	22	49
1908-09	34	26	60	120
1909-10	72	43	60	175
Total printed	126	81	142	349
Total in programme	2,160	2,067	2,101	6,328
Number remaining for publication	2,034	1,986	1,959	5,979

The office is in a position to deal with a considerably larger number of sheets and will be able to undertake all the work required when parties and circle drawing offices send in their full estimated outturn.

Special maps.—In addition to the above series of maps the office has dealt with a large number of special maps, of which the most important are the following:—

New railway map on the 64-mile scale (under preparation).

New railway, road, and canal map on the 32-mile scale (under preparation).

Map of the N. E. frontier of India on the 32-mile scale (nearing completion).

Postal map of Sind on the 8-mile scale (under preparation).

Old style maps.—Of old maps which are not likely to be superseded in the near future, 229 were prepared for reprinting by the addition of such information as was available, and of these 164 were printed.

DRAWING AND ENGRAVING OFFICES.

Provisional degree sheets.—Many years must elapse before the new degree sheets on the $\frac{1}{4}$-inch scale extend over India, and much inconvenience arises from the fact that the old series of maps on this scale, namely the Atlas sheets, do not conform to the new series in shape, in graticule or in area, with the result that the publication of a sheet of the new series will not wholly supersede any one Atlas sheet.

It has been decided therefore to prepare provisional degree sheets by cutting and joining the old $\frac{1}{4}$-inch maps in the same form as the new series. In this way, sheets of the old style will be superseded with moderate rapidity, and every new sheet prepared from modern surveys will displace completely one of the provisional maps; overlapping and confusion will thus be avoided. Experiments are being made in order to arrive at the best and most economical method of effecting this conversion, which is a matter of considerable technical difficulty.

Stamps for symbols.—Stamps for the printing of the various conventional symbols have for some time been wanted, and many experiments have been made in the search for a suitable method of making them. A satisfactory plan has been discovered and it is intended to provide full equipments of symbols to all parties and circle drawing offices, and so to attain to uniformity in the conventional representation of natural and artificial features.

Hill shading.—A variety of experiments in methods of hill shading have been carried out. An endeavour has been made to substitute the stump for the brush as it expedites the work, but it is in many respects inferior and the success of the experiment is still doubtful. The air brush, a mechanical device for spraying ink, has also been tried for certain purposes and it is hoped that it will be found of use.

The following table shows the volume of work in the office during the year.

I.—Maps of the modern series.

Class of Map.	Number of sheets in hand.	Number completed and sent to press.
Geographical maps $\frac{1}{1,000,000}$ and smaller scales ...	99	39
1 inch = 4 miles (Degree sheets, &c.)	64	30
1 inch = 1 mile (Standard sheets)	242	208
Totals ...	405	277

II.—Old style maps, reprints and other plans and charts.

Standard maps	212	164
Miscellaneous maps and charts	157	131
Maps for other departments	133	81
Totals ...	502	376

PHOTO.-LITHO. OFFICE.

Three-colour photography.—Perhaps the most interesting results obtained during the year are those of Mr. Taylor, Manager of the Photo. Branch, in his experiments with three-colour photography.

The rapid deterioration of colour-sensitive plates in the Indian climate has made this process both uncertain and expensive, and it has been Mr. Taylor's aim to produce a bromide of silver emulsion in collodion for coating plates, which would render them suitable to take the place of imported dry plates in this process. In this he has attained to a remarkable degree of success, and it is hoped that before long the office will be able to take up reproduction in colours as a regular branch of its business. At present this will not perhaps be much used by the Survey of India itself, but it should be of value to several other departments of Government.

The output of the printing section of the office during the last three years is shewn in the following table.

Year.	Number of impressions pulled.	Number of maps printed.		
		Departmental.	Extra-departmental.	Total.
1907-08	1,563,453	891	1,175	2,066
1908-09	1,506,607	2,047	726	2,773
1909-10	1,574,180	2,697	1,053	3,750

The cost of the office during the year was Rs. 1,54,494, and the value of the outturn Rs. 2,13,894 including Rs. 51,586 recovered in cash or by book debit transactions. These figures compare favourably with those of the preceding year, which were: cost Rs. 1,58,643, value of outturn Rs. 1,72,234.

MAP RECORD AND ISSUE OFFICE.

The gross face value of the maps received from the printing offices during the year amounted to Rs. 3,40,000. This sum includes Rs. 15,361 and Rs. 25,014, the values of maps printed in the Engraving Office and at Dehra Dún respectively.

The following table shows the maps printed and received and their face value.

	Class of maps.	Scale.	Number of different maps of each class received.		Value.
			New publications.	Reprints.	
					Rs.
1	Geographical maps ...	Small	5	5	44,850
2	India and Adjacent Countries	$\frac{1}{1,000,000}$	2	9	4,504
3	Degree sheets	1 in. = 4 m.	10	2	5,650
4	Standard sheets (new style) ...	1 in. = 1 m.	205	3	1,04,305
5	Provincial maps	1 in. = 16 m. 1 in. = 32 m.	2	11	14,675
6	District maps	1 in. = 4 m.		13	2,755
7	Atlas sheets	1 in. = 4 m.	.....	119	13,776
8	Standard sheets (old style) ...	1 in. = 1 m.	76	121	89,321
9	Administration Report maps	1 in. = 8 m.	.....	37	1,632
10	Plans of Cities and Cantonments	Various	25	24	21,285
11	Triangulation and traverse charts	Various	58	.....	1,625
12	Index maps	Various	54	30	17,778
13	Miscellaneous maps ...	Various	48	38	17,884
	Totals ...	.....	483	412	3,40,000

The total number of printed maps issued during the year was 1,42,421, of an aggregate value of Rs. 1,24,858. The details of the sales were as follows.

Sales to	Number of maps.	Value.
		Rs.
Government Officials	74,469	45,929
India Office	5,759	7,508
Departmental issues	40,803	51,763
Private individuals	19,230	17,617
Agents	1,980	2,041
Totals ...	1,42,421	1,24,858

A new catalogue of maps corrected up to February 1st 1910 was published during the year.

MATHEMATICAL INSTRUMENT OFFICE.

There has been a large falling off in the demand for new instruments and also for the manufacture and repair of instruments required to be done in the workshops. In the former case the diminution amounted to 32 per cent. and in the latter to 24 per cent. on the average values of the two previous years.

This heavy decrease in demand and the consequent increase in the value of the stock in hand, on which $3\frac{1}{2}$ per cent. interest charges are levied, have combined to show deficits in the profit and loss accounts of the instrument store and workshops, amounting in the former case to Rs. 20,176 and in the latter to Rs. 15,270.

Good progress has been made in the manufacture of more delicate instruments, such as theodolites, levels, clinometers and all descriptions of scales and offsets; the dividing and engraving of the latter have been greatly facilitated by two new machines, an automatic dividing machine and an engraving machine, which were installed during the year.

A noteworthy piece of work was the design and manufacture of the largest adjustable plan board that has ever been made or used in India. This plan board measures 11 feet 9 inches by 10 feet 3 inches, and the whole weight is taken by a ball-thrust which makes its adjustment particularly easy. It is now in use in the studio of the Photo.-Litho. Office, in connection with the photographic reduction of combined standard sheets for the preparation of degree sheets on the $\frac{1}{4}$-inch scale.

II.—DEHRA DÚN OFFICES.

A. SPECIAL OPERATIONS.

The erection of the base line observatory was commenced in May 1909. In accordance with instructions received from the Secretary of State, the plans were sent home for Sir David Gill's inspection. Building operations had to be temporarily suspended but were resumed on receipt of the plans from Sir David.

Approximate sites for the measurement of base lines in Burma and Baluchistán have been selected; and a complete apparatus of wires has been purchased to replace the old compensation bars.

Photographs of the sun were taken on 337 days in the year. It is hoped that on the 28 days when the sun was completely obscured, photographs of it were secured either at Greenwich or Mauritius.

B. COMPUTING SECTION

The chief points of interest in the work of this section are as follows:—

Geodetic work.

During the summer of 1910 the simultaneous reduction of the levelling was completed. All closing errors of circuits were eliminated, the level net was tied to sea level at nine different ports, orthometric corrections were applied, and adjusted values for the heights of all bench-marks fixed between 1858 and 1909 were obtained. A complete account of the levelling operations of the Survey,—of the methods of observation, of the instruments and bench-marks, of the connections with sea level, of the accuracy of results,—has now been published in Volume XIX of the *Account of the Operations of the Great Trigonometrical Survey of India.*

The publication of this volume marks the close of the first half-century of levelling work in India, and provides a scientific and consistent basis for the levelling operations of the future.

Geographical work.

Barometric observations for height in Central Asia by Doctor Stein and clinometric observations for heights of certain Himalayan peaks by Doctor Longstaff were reduced, and the results supplied to the Drawing Office for incorporation in maps.

Computations of Captain Robinson's triangulation in Kohistán and Sind Ságar Doab during 1851—59 were partly undertaken, for incorporation in the trans-frontier degree triangulation charts.

The co-ordinates and heights of a few more peaks from Captain Wood's triangulation in Western Tibet were computed and adjusted, for incorporation in the map of Tibet.

Certain tables of the 4th edition of the Auxiliary Tables were extended to 45° N. latitude, for inclusion in a smaller edition for the use of explorers.

Synoptical Volume No. XXXV of the North East Longitudinal Series passed through the press and was issued. This volume furnishes data of points in the Himalayas from Dehra Dún to Assam, and some of the highest peaks in the world fall within its area. The new system of numbering Himalayan peaks mentioned on page 15 of the General Report for 1907-08 has been adopted in it. Mount Everest will in future be known as $\frac{\text{Peak } 57}{\text{Tr. I.}}$ in addition to its old name.

Preservation of trigonometrical stations.

695 Principal stations of the 3,598 in existence were repaired by district officers at a cost of Rs. 4,057; 15 old stations were reported as destroyed, and 25 new stations were added. Out of 333 districts from which reports are due annually, 18 failed to make returns.

C. DRAWING SECTION.

The following table shows the volume of work undertaken.

Class of map.	Number of sheets in hand.	Number of sheets drawn and sent to press.
Geodetic and scientific diagrams and charts ...	218	116
Geographical maps, $\frac{1}{M}$ and smaller scales ...	11	4
Miscellaneous indexes and plans	8	7
Special maps for Doctor Stein	94	94
Totals ...	331	221

D. PHOTO.-ZINCO. SECTION.

1,750 maps and diagrams were photographed against 1,478 in 1908-09. The number of impressions pulled was 3,02,909 against 2,67,732 in the previous year. The machine lithographic press was employed throughout the year printing the maps of Doctor Stein's exploration, cantonment and forest maps and triangulation and levelling charts.

E. FOREST MAP OFFICE.

The number of maps issued to Forest and other officials during the year was 9,662 against 7,689 issued in 1908-09, and the amount realised by sales amounted to Rs. 1,555 against Rs. 3,312 in the previous year.

The following table shows in abstract from the work dealt with by the office.

Class of map.	Number of Sheets.		
	In hand.	Drawn and sent to press.	Published.
Standard maps of Forest Surveys	229	69	46
Special maps of India	8	8	6
Provincial, Divisional and District Forest maps ...	9	4	5
Working plans and miscellaneous maps ...	15	7	8
Totals ...	261	88	65

The space for the storage of maps in the present building is insufficient to meet the demands which will eventually be made on it, and proposals have been submitted for its extension by the erection of a new building.

III.—CIRCLE AND LOCAL DRAWING OFFICES.

A. NORTHERN CIRCLE DRAWING OFFICE.

The normal main work of the office was the examination of standard sheets drawn by the various parties, the drawing and examination of sheets which the parties (either from insufficient establishment or owing to a short recess season) had been unable to undertake, the preparation of special editions of standard sheets, and the drawing of degree sheets.

The office also undertook the drawing of certain sheets of the $\frac{1}{M}$ series and the examination of standard sheets prepared in the United Provinces Drawing office mentioned below.

The following is a summary of the special work in hand and sent to press.

Class of map.	Scale.	Number of Sheets.	
		In hand.	Drawn and sent to press.
Map of Turkistan	1 in. = 32 m.	1	.....
India and Adjacent Countries	$\frac{1}{1,000,000}$	5	1
Degree sheets	1 in. = 4 m.	18	4
Totals ...	.....	24	5

B. SOUTHERN CIRCLE DRAWING OFFICE.

The final examination of eight standard sheets was completed and assistance was given to the Eastern Circle Drawing Office in the completion of their arrears of mapping, and to the various parties in the Southern Circle in their current mapping.

The Photo.-zinco detachment of the office was taken over from the Eastern Circle and was fully occupied with photographic and vandyke work.

C. EASTERN CIRCLE DRAWING OFFICE.

The following table shows the number of maps and charts in hand and sent to press during the year.

Class of map.	Scale.	Number of Sheets.	
		In hand for drawing, completion, or examination.	Sent to press.
Standard sheets	1 in. = 1 m.	59	59
Forest editions of above	2 in. = 1 m.	9	9
Village boundary editions of standard sheets ...	1 in. = 1 m.	5	5
Triangulation charts	1 in. = 4 m.	12	9
Degree sheets	1 in. = 4 m.	7	3
Miscellaneous maps	1 in. = 4 m.	2	2
Standard sheets (old form)	1 in. = 1 m.	4	4
Totals ...	.....	98	91

D. BENGAL DRAWING OFFICE.

(Imperial Section).

The standard mapping section of this office continued its work of compilation of standard sheets from modern cadastral surveys for publication as preliminary editions in black only.

71 standard sheets covering an area of 9,748 square miles were dealt with; of these 14 have been submitted for publication and 6 are nearly complete. One traverse chart was completed.

E. UNITED PROVINCES DRAWING OFFICE.

This office was again employed under the Superintendent, Northern Circle, on the compilation of standard sheets in the United Provinces in both new and old styles from old cadastral surveys.

The new style sheets will be published as preliminary editions in colours, the old style sheets in black.

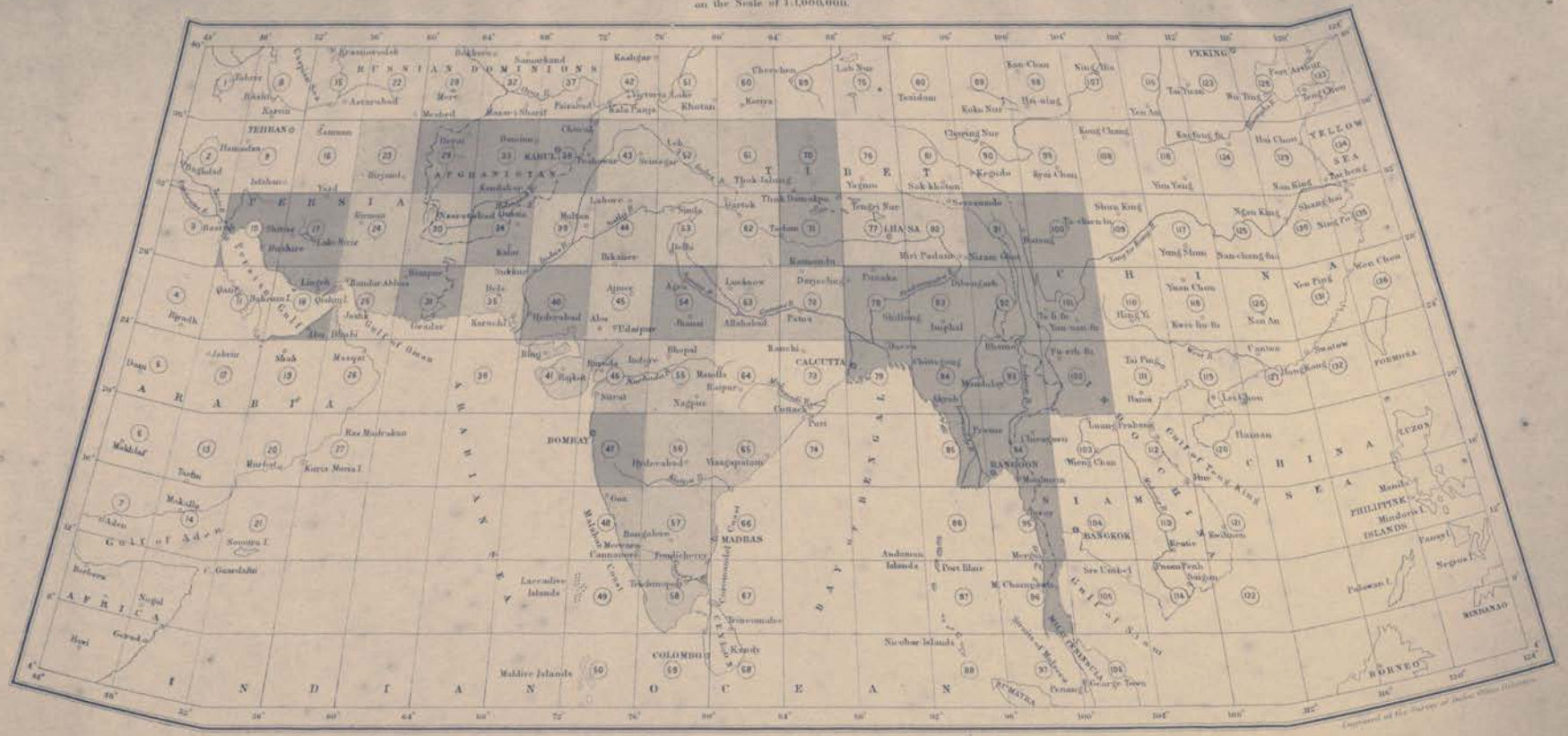
Twenty one sheets in the new and two in the old style were drawn and submitted for publication, and forty seven traverse charts were completed.

PRINTED AT THE PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, SURVEY OF INDIA, CALCUTTA.

INDEX TO THE SHEETS OF THE

INDIA AND ADJACENT COUNTRIES SERIES

on the Scale of 1:1,000,000.



Published under the direction of The Hon'ble Colonel F. B. Longe, R.E., A.D.C., Surveyor General of India.

1910.

Scale 1:1,000,000.

Miles 100 0 100 200 300 Miles.

Engraved at the Survey of India Office, Calcutta.

REFERENCE.

Sheets published

" under publication

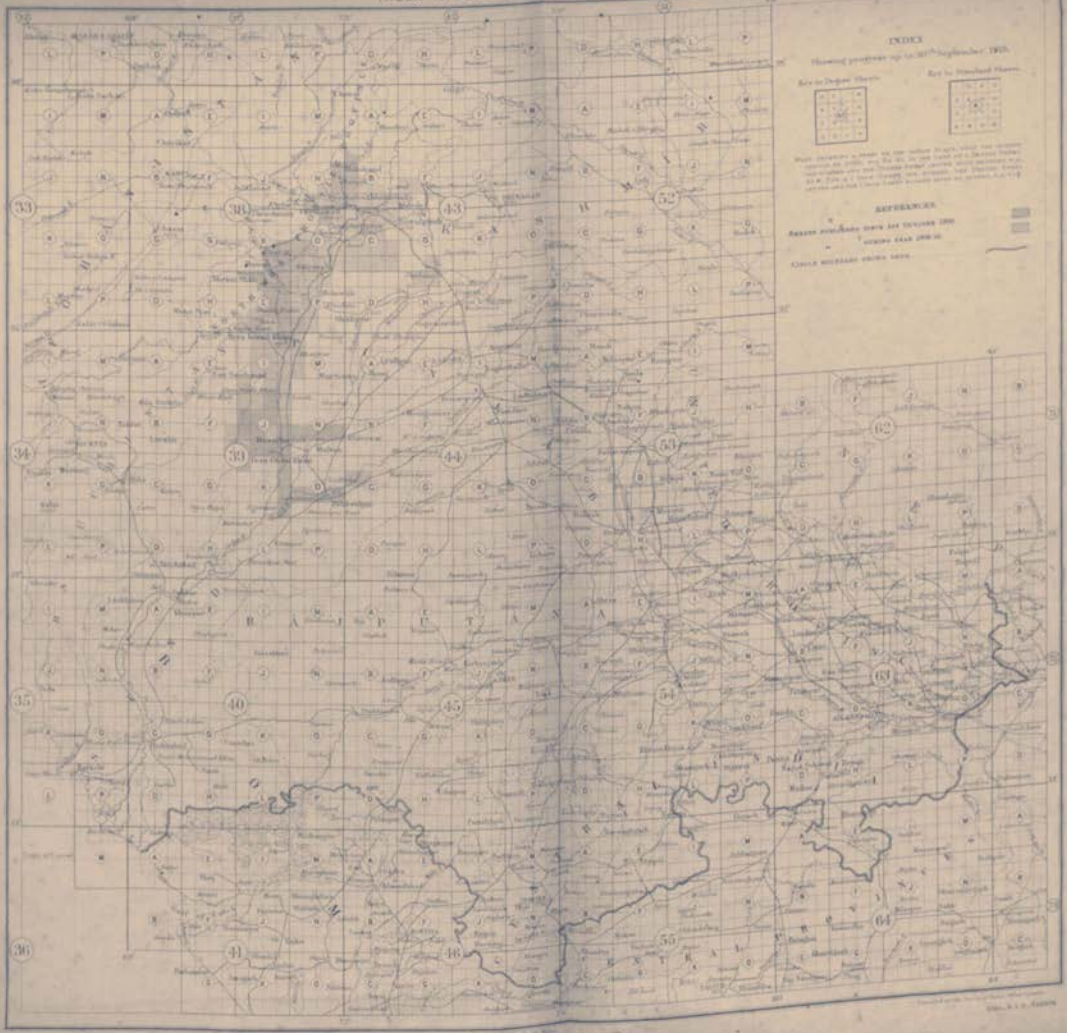
" in hand

Reg. No. 1183 D., 11.—8. 1.—1,000.

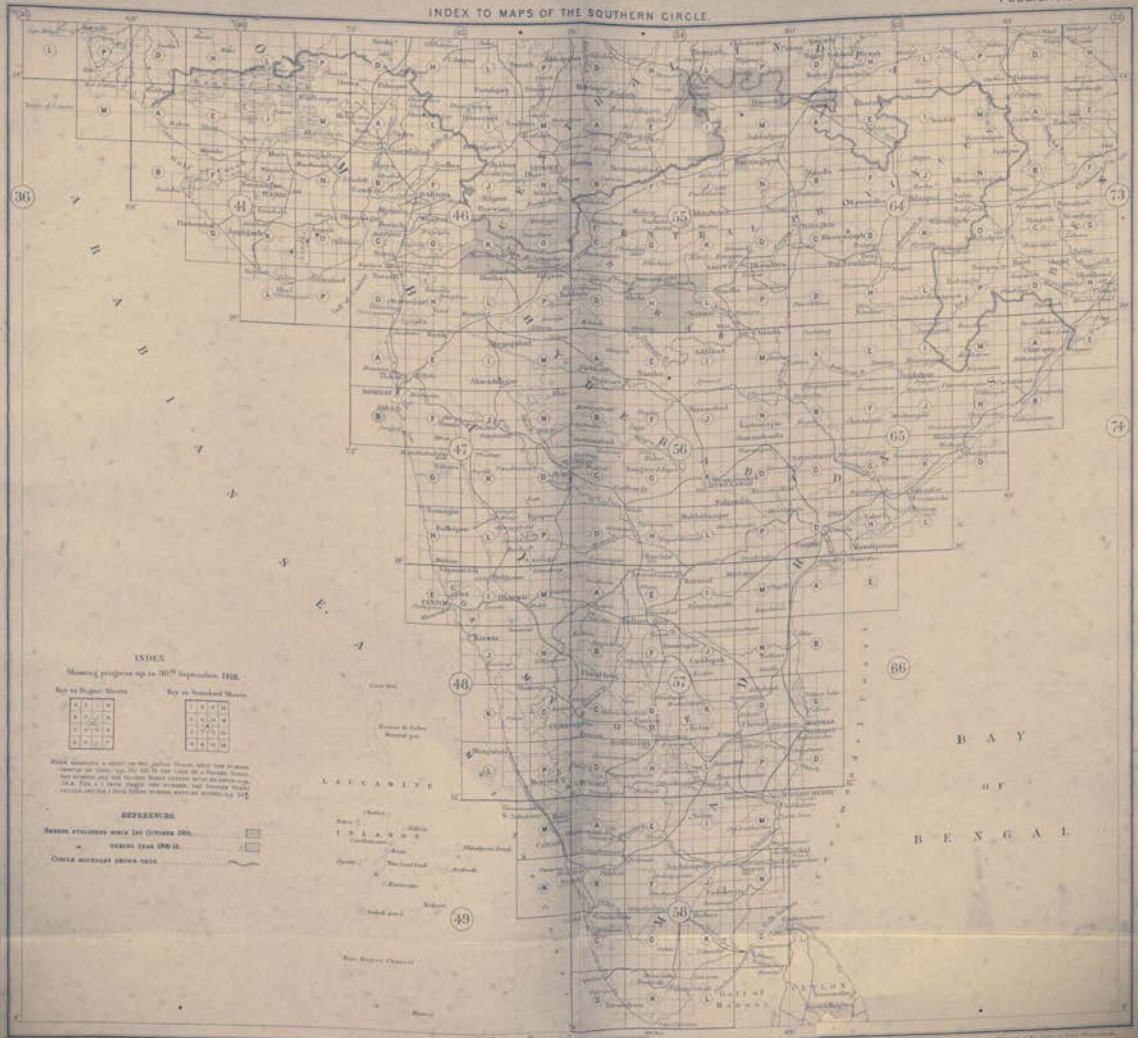
Litho., S. I. O., Calcutta.

INDEX TO MAPS OF THE NORTHERN CIRCLE

PUBLICATION.

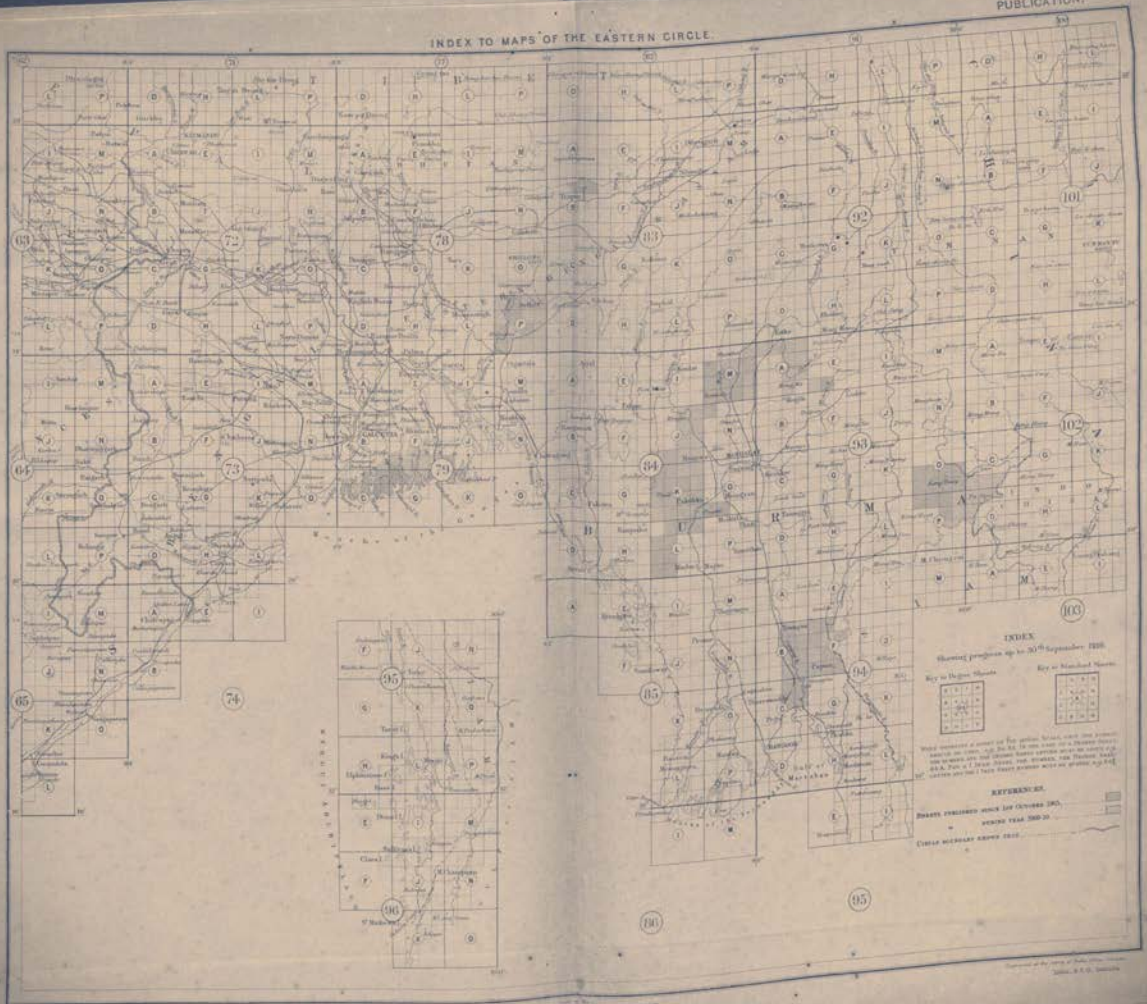


INDEX TO MAPS OF THE SOUTHERN CIRCLE.



PUBLICATION.

INDEX TO MAPS OF THE EASTERN CIRCLE



GENERAL REPORT

ON THE

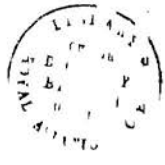
OPERATIONS

OF THE

Survey of India,

DURING THE SURVEY YEAR

1910-11.



PREPARED UNDER THE DIRECTION OF

COLONEL S. G. BURRARD, C.S.I., R.E., F.R.S.,

SURVEYOR GENERAL OF INDIA.

Printed at the Photo.-Litho. Office, Survey of India,

CALCUTTA,

1912.

Printed at the
Photographic and Lithographic Office, Survey of India,
14, Wood Street,
Calcutta.

PREFACE.

This report is intended to be general and concise. More detailed descriptions and discussions of results will be found in the Volume, " Records of the Survey of India, 1910-11."

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8 ,, ,, ,, ,, ,, ,, Southern ,,

9 ,, ,, ,, ,, ,, ,, Eastern ,,

10 Index to the publication of Degree Sheets, Scale $\frac{1}{4}$ inch = 1 mile.

11 Index to the publication of Sheets of the "India and Adjacent Countries" Series, Scale $\frac{1}{1,000,000}$.

12 Index Chart to the Great Trigonometrical Survey.

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1910-1911

PART I.

ADMINISTRATION.

1. This report deals with the operations of the Survey of India for the year ending 30th September 1911.

2. The Honorable Colonel F. B. Longe, C.B., R.E., A.D.C., administered the Department till the 24th October, when he went on leave pending retirement, and Colonel S. G. Burrard, C.S.I., R.E., F.R.S., officiated as Surveyor General for the remainder of the year.

3. In January 1911 the N. W. Frontier Drawing Office was transferred to Simla, and in April the drawing office of the Chief of the General Staff was amalgamated with it, under the name of the "Simla Drawing Office."

4. The Burma Drawing Office was amalgamated with the office of the Superintendent, Eastern Circle.

5. No new Imperial Officers were appointed during the year under report, but 4 probationers were appointed to the Provincial Service (new).

6. No. 9 Party although nominally in the Eastern Circle continued to work under the direction of the Superintendent, Northern Circle; it will, however, in future, be under the Superintendent, Eastern Circle.

7. The cost of the department for the financial year ending 31st March 1911, was Rs. 33,47,212, against an estimated cost of Rs. 34,56,050.

8. The distribution of the officers in the various offices and parties is shown in the accompanying list.

DISPOSITION OF OFFICERS,

1910-11.

Circle.	Administrative Officer.	Party or Office.	Locality.	Imperial Officers.	Provincial Officers.	Upper Subordinates.	Lower Subordinate Establishment.	Remarks.
	The Hon'ble Colonel F. B. Longe, C.B., R.E., A.D.C., up to 24th October 1910.	....	Calcutta ...	.....	.....	.....	.....	
	Colonel S. G. Burrard, C.S.I., R.E., F.R.S., from October 25th.	Surveyor General's Office and Mathematical Instrument Office.	Calcutta ...	Captain R. H. Thomas, R.E., Captain M. N. MacLeod, R.E., Captain F. F. Hunter, I.A.	.....	.....	.....	
		Simla Drawing Office.	Simla ...	Major H. L. Crosthwait, R.E., Captain M. N. MacLeod, R.E., Lieut. P. G. Huddleston, R.E.	Messrs. J. P. Barker, H. T. Hughes, F. C. Saint.	.....	.....	
MAP PUBLICATION.	Lieut.-Col. G. P. Lenox-Conyngham, R.E., till March 2nd 1911, Major W. M. Coldstream, R.E., from March 3rd 1911, *Superintendent, Map Publication.*	Map Publication Office.	Calcutta ...	.....	Mr. M. Gastaud ...	.....	.....	
		Drawing Office						
		Map Record & Issue Office.	Calcutta	Captain M. O'C. Tandy, R.E.	Messrs. C. A. Norman, P. J. Barrington, J. O. Greiff, Jagdamba Prasad, H. A. Charrier, P. L. Causley, J. R. Newland, P. Simpson, P. N. Sur, J. Hickie (re-employed), E. B. West, E. J. Hanby.	.....	.....	
				Captain O. H. B. Trenchard, R.E.				
		Engraving Office.						
		Photo.-Litho. Office.	Calcutta ...	Captain O. H. B. Trenchard, R.E., Captain A. H. Gwyn, I.A., Lieut. K. W. Pye, R.E.	...		.....	

NORTHERN.	Colonel W. J. Bythell, R.E., *Superintendent, Northern Circle.*	Northern Circle Drawing Office	Mussoorie ...	.....	Messrs. G. P. Tate, R. Waller-Senior, B. R. Hughes, H. G. Shaw, M. C. Petters, E. C. J. Bond.	Husain Buksh, K. S.	44 Clerks, Draftsmen, &c.	
		No. 1 Party ...	Kashmir ...	Major C. H. D. Ryder, D.S.O., R.E., Bt.-Major E. T. Rich, R.E., Lieut. J. D. Campbell, R.E., Lieut. A. A. Chase, R.E., Lieut. K. Mason, R.E.	Messrs. T. W. Babonau, H. H. B. Hauby, E. B. West, D. K. Rennick, R. C. Hanson, W. J. B. Miller, W. P. Hales, Jiya Lal.	Sher Jang, K. B., Natha Singh, R. S., Lal Singh, R. B., Mahindar Singh, Mohammed Husain Khan.	25 Surveyors, &c.	
		No. 2 Party ...	Punjab ...	Bt.-Major E. T. Rich, R.E., Capt. M. N. MacLeod, R.E., Lieut. J. D. Campbell, R.E., Lieut. C. M. Thompson, I.A.	Messrs. T. W. Babonau, F. B. Powell, W. Newland, Subadar Kanak Singh, Messrs. R. E. Saubolle, E. C. O'Sullivan, J. McCraken, Jiya Lal.	Chuni Lal Kapur, Mahindar Singh.	42 Surveyors, &c.	
		No. 3 Party ...	Punjab and U. P.	Capt. A. A. McHarg, R.E., Lieut. A. A. Chase, R.E., Lieut. R. S. Wahab, I.A.	Messrs. B. M. Berrill, A. C. Bose, P. A. T. Kenny, H. C. W. Stotesbury, B. C. Newland, A. J. A. Drake, F. H. Grant, F. J. Grice, J. A. Calvert.	Mahomed Lutf Ali.	44 Surveyors, &c.	
		No. 4 Party ...	United Provinces	Captain L. C. Thuillier, I.A., Lieut. F. B. Scott, I.A.	Messrs. G. J. S. Rae, H. W. Biggie, C. E. C. French, A. B. Hunter, G. E. R. Cooper, F. E. R. Calvert, Moqimuddin.	Vidya Nath Suri, Mohammad Husain Khan.	69 Surveyors, &c.	Includes establishment of Cantonment Section No. 1.
		No. 9 Party ...	Punjab ...	Major G. A. Beazeley, R.E.	Messrs. J. A. Freeman, W. Newland, Dhani Ram, F. Byrne, P. A. T. Kenny, H. C. W. Stotesbury, D. K. Rennick, J. McCraken, A. K. Mitra, A. J. A. Drake, Abdul Aziz, H. H. P. Butterfield, W. P. Hales, F. J. Grice.	Gopal Singh, R. B., Dalbir Rai.	60 Surveyors, &c.	This Party was transferred to Eastern Circle from 1st April 1911.
		Riverain Detachment.	Punjab ...	.....	Messrs. Maya Das Puri, Moqimuddin	Chuni Lal Kapur.	75 Traversers, Computers, &c., 53 Tehsilders, Patwaris, &c.	
		United Provinces Drawing Office.	Mussoorie ...	.....	Mr. J. M. Kennedy ...	.....	21 Draftsmen, Clerks, &c.	

Circle.	Administrative Officer.	Party or Office.	Locality.	Imperial Officers.	Provincial Officers.	Upper Subordinates.	Lower Subordinate Establishment.	Remarks.
SOUTHERN.	Bt.-Col. T. F. B. Renny-Tailyour, C.S.I., R.E., up to 23rd March 1911, and from 23rd September 1911. Lt.-Col. P. J. Gordon, I.A., from 24th March 1911 to 22nd September 1911, *Superintendent, Southern Circle.*	Southern Circle Drawing Office.	Bangalore ...	.....	Messrs. A. Ewing, Abdul Rahim, K.S.	Mr. B. V. Narayana Rao.	30 Draftsmen, &c.	
		Southern Circle Training Section.	Bangalore ...	.....	Messrs. J. Smith, Abdul Rahim, K.S.	Messrs. Jugal Behari Lal, Ram Narayan Hastir, B. P. Muthannah, K. Mandanna.	9 Surveyors, &c.	
		No. 5 Party ...	Central Provinces & Central India.	Maj. C. L. Robertson, C.M.G., R.E., Lieut. C. F. Nation, R.E.	Messrs. F. P. Walsh, C. Litchfield, S. S. McA'Fee Fielding, C. West, Munshi Lal, F. C. Pilcher, E. J. Hanby, F. C. Saint.	Mr. Eknath Battu.	32 Surveyors, &c.	
		No. 6 Party ..	Bombay, Central Provinces, Berár and Hyderábád.	Capt. H. Wood, R.E., Capt. F. F. Hunter, I.A., Lieut. K. W. Pye, R.E., Lieut. A. H. Gwyn, I.A., Lieut. J. A. Field, R.E.	Messrs. Amar Sing, J. H. S. Wilson, P. ff. Anderson, E. A. Meyer, F. B. Kitchen, R. B. Gilden, J. O'C. Fitzpatrick, A. J. Moore.	Mr. Dharmu ..	41 Surveyors, &c.	
		No. 7 Party ...	Bombay, Madras, Mysore & Coorg.	Lieut.-Colonel P. J. Gordon, I.A., Capt. C. P. Gunter, R.E., Lieut. K. W. Pye, R.E., Lieut. A. H. Gwyn, I.A.	Messrs. W. M. Gorman, J. O'B. Donaghey, H. D. W. Stotesbury, A. K. Mitra, H. H. P. Butterfield, J. C. St. C. Pollet.	Mr. Abdul Hakk	26 Surveyors, &c.	
		No. 8 Party ...	Madras	Captain C. M. Browne, D.S.O., R.E., Lieut. S. W. S. Hamilton, R.E., Lieut. C. G. Lewis, R.E.	Messrs. W. F. E. Adams, E. J. Piggie, S. F. Norman, M. Mahadeva Mudaliar, C. O. Picard, Balaji Dhondiba, M. S. Ganesa Aiyar.	Mr. Anantarao Dhondiba.	30 Surveyors, &c.	
EASTERN.	Bt.-Col. G. B. Hodgson, I.A., *Superintendent, Eastern Circle.*	Eastern Circle Drawing Office.	Shillong, Assam.	.....	Messrs. P. J. Barrington and E. M. Kenny.	Raghubar Datt Thapdyal, Motindra Ranjan Mazumdar.	3 Surveyors, 6 Draftsmen, 10 pupil Draftsmen, 1 pupil Surveyor, 8 Clerks.	
		No. 9 Party (in Northern Circle)	.....	.....	.....	.....	.....	
		No. 10 Party ..	Upper Burma ..	Captain E. C. Baker, R.E., Lieut. W. E. Perry, R.E.	Messrs. O. D. Smart, F. S. Bell, P. Williams, C. S. Littlewood, W. G. Jarbo, Asmatullah Khan, W. H. Strong, C. B. Sexton.	Lachman Daji Jadu, R.S., Hayat Muhammad, B. C. H. Collins.	40 Surveyors &c., 6 pupils.	
		No. 11 Party ...	Southern Shan States.	Capt. R. H. Phillimore, R.E., Lieut. J. A. Field, R.E.	Messrs. V. W. Morton, T. P. Dewar, A. A. Graham, H. St. J. Kenny, A. J. Booth, R. M. Wyatt.	...	25 Surveyors, &c. and 3 pupils.	

Colonel S. G. Burrard, C.S.I., R.E., F.R.S., till October 24th, J. Eccles, Esq., M.A., from October 25th, *Superintendent, Trigonometrical Surveys.*	No. 12 Party ...	Assam ...	Major A. Mears, I.A., Lieut. G. F. T. Oakes, R.E.	Messrs. W. Skilling, C. C. Byrne, Pramadaranjan Roy, J. H. Williams, Amjad Ali, L. Williams, P. C. Mitra, H. H. Creed.	Nanakchand Puri.	40 Surveyors, &c. and 1 pupil.	
	Trigonometrical Surveys Office.	Dehra Dún ...	J. de G. Hunter, Esq., M. A.	Messrs. J. P. Barker, J. H. Nichol, Aulad Hussein, O. C. Ollenbach, H. A. Charrier, A. V. Dickson, N. N. Chuckerbutty, A. F. Murphy, D. N. Banerji.	Ram Singh, R. S., Sarat Kumar Mukerji.	.....	Special establishment.
	No. 13 Party ...	Sind and Baluchistán.	Major H. L. Crosthwait, R.E.	*Nil.*	Bidhu Bhusan Shome.	2 Computers, &c.	
	No. 14 Party ...	Burma ...	Major E. A. Tandy, R.E., Capt. H. McC. Cowie, R.E.	Mr. Hanuman Prasad ...	*Nil.*	4 Computers, &c.	
	No. 15 Party ...	Upper Burma, Kashmír, Assam	Major H. H. Turner, R.E., Lieut. E. B. Cardew, R.E., Lieut. F. J. M. King, R.E., Lieut. H. E. Bell, R.E., Lieut. K. Mason, R.E.	Messrs. H. B. Simons, C. H. Tresham, Abdul Hai, V. D. B. Collins, F. W. Smith, G. A. Norman, B. T. Wyatt, Abdul Karim, K. S., Gopalachari, V. P. Wainwright, C. S. McInnes.	Bidhu Bhusan Shome.	21 Computers, &c.	
	No. 16 Party ...	Indian Ports ...	Major J. M. Burn, R.E. ...	Messrs. H. G. Shaw, Syed Zille Hasnain.	*Nil.*	20 Computers, &c.	
	No. 17 Party ...	Bombay, Madras, Punjab & Assam.	Lieut.-Col. P. J. Gordon, I.A., Lieut.-Col. G. P. Lenox-Conyngham, R.E.	Messrs. E. H. Corridon, A. M. Talati, O. N. Pushong, D. H. Luxa, T. F. Kitchen, O. D. Jackson.	Karuna Kumar Das.	9 Computers, &c.	
	No. 18 Party ...	India ...	Capt. R. H. Thomas, R.E., Capt. H. J. Couchman, R.E., Lieut. H. T. Morshead, R.E.	Messrs. E. C. J. Bond, H. P. D. Morton, Rama Prasad Ray, N. R. Mazumdar, Rai Bahadur Mathur.	*Nil.*	19 Computers, &c.	
	Forest Map Office.	Dehra Dún ...	Major J. M. Burn, R.E. ...	Messrs. A. Descubes (re-employed), J. H. Nichol.	*Nil.*	*Nil.*	

PART II.

SURVEY WORK IN THE FIELD.

I.—TOPOGRAPHICAL SURVEYS.

NORTHERN CIRCLE (*vide* index map No. 1).

9. *No. 1 Party.*—This party remained in recess quarters at Mussoorie during the winter, and left for the field in Kashmír in March. Field work was started about the middle of the month, and by the end of September an area of 3,514 square miles had been surveyed on the 1-inch scale in the Jhelum Valley; the country surveyed varying from the level swampy valley, to the high ranges of the Pír Panjál and Káj Nág.

10. *No. 2 Party.*—No. 2 party surveyed an area of 1,026 square miles on the 2-inch scale* in the Salt Range, and one of 4,971 square miles on the 1-inch scale in the Attock, Jhelum, Sháhpur, Gujránwála, Gujrát and Sialkot districts of the Punjab and in the native state of Jammu. With the exception of the Salt Range, the country surveyed lay in level plains, well cultivated, and intersected by the Jhelum, Chenáb and Rávi rivers, and by numerous irrigation canals.

11. *No. 3 Party.*—This party surveyed a total area of 6,282 square miles, of which 5,955 square miles were 1-inch revision survey, 65 square miles 2-inch revision survey and 262 square miles 1-inch supplementary survey. The 2-inch survey comprised the city of Delhi and its environs, and a special guide map of this area has been drawn on that scale. The 1-inch survey comprised parts of the Delhi and Gurgaon districts of the Punjab, and parts of the Meerut, Aligarh, Morádábád, Budaun and the whole of the Bulandshahr districts of the United Provinces. With the exception of the Ridge at Delhi and its continuation to the south, the country was flat, with a gradual slope of about 18 inches to the mile and an average height of 650 feet above sea level; between the Jumna and Ganges rivers it was much cut up by canals. In both methods of 1-inch survey, every use was made of the old 1-inch maps based on cadastral surveys, and the majority were found extremely good. Their use greatly facilitated progress, and the resulting maps show a large amount of detail.

12. *No. 4 Party.*—No. 4 party surveyed an area of 6,048 square miles in the districts of Lucknow, Unao, Cawnpore and Etáwah, with portions of districts Hardoi, Rái Baréli, Farrukhábád, Mainpuri, Agra, Hamírpur, Jalaun and of Gwalior State. The country surveyed consisted chiefly of flat plains, well cultivated and covered with an abundance of artificial groves. The rivers Ganges, Jumna and Chambal ran through portions of the work, and there the country was much cut up by deep ravines. A traverse section of this party ran traverses (to supplement older work) over an area of 6,236 square miles. The Cantonment Section surveyed the Cantonments of Dargai, Malakand, Chakdarra, Hyderábád (Sind), and Loralai, and additions were made to previous surveys of Risalpur and Alláhábád. Maps of eight Cantonments were sent for publication, *viz.*, Dum Dum, Meerut, Lucknow, Fort Sandeman, Dargai, Malakand, Chakdarra and Alláhábád.

Proofs of eight cantonment maps were received for colouring, *viz.* Dharmsála, Shillong, Dum Dum, Meerut, Dargai, Malakand, Chakdarra and Lucknow.

13. *No. 9 Party.*—No. 9 party surveyed an area of 5,687 square miles on the 1-inch scale in the Jhang, Miánwáli, Sháhpur, Lyallpur, Gujránwála, Lahore and Montgomery districts of the Punjab. The country surveyed was generally flat, and varied from low rolling sand-hills covered with scanty scrub and a few

* At the request of the Punjab Government.

stunted trees, to the fertile, well watered and closely cultivated lands of the Chenáb colony in the Lyallpur district. In this party considerable use was made of the *patwari's* maps, which were pantographed down, and the reductions transferred to the plane-table sections.

14. *The Punjab Riverain Detachment.*—This detachment continued the work of traversing and laying down base lines for the future demarcation and survey of riverain boundaries, and for the general co-ordination of the cadastral surveys of the Punjab Government. The original programme was modified, and traversing was carried out for cadastral surveys on the rivers Sutlej, Beás, Jhelum, and Chenáb, and for riverain boundaries on the Jumna and Indus. 436 linear miles of main traverse and 1,844 miles of minor traverse were completed along these rivers and 456 base lines were laid down with permanent mark-stones.

15. 1,806 "*musavis*" were plotted, in addition to 372 which showed riverain boundaries. 101 4-inch sheets were traced and 21 were compiled.

16. The above were for the Settlement Department, and for the riverain, 5 4-inch sheets were compiled, 21½ finally examined, and 9¾ typed. This detachment also carried out a special survey on the scale of 4 inches to the mile, at the request of the Assistant Commanding Royal Engineer, along the Indus near Dera Ismail Khán—an area of 53 square miles being traversed and plane-tabled, and the work being completed with some difficulty on the 22nd October 1911.

17. About the middle of January 1911, orders were received from the Punjab Government for the resumption of the Lower Bári Doáb 25-acre Rectangular Survey, which had been in abeyance since 1909. Work was started on the 14th February, closed on the 10th June, and re-started on the 1st September with an increased staff. In all 4,164 rectangles were broken and 140 linear miles of traversing were completed. The operations will extend over an area of some 2,500 square miles, which will eventually be commanded by the Lower Bári Doáb canal.

SOUTHERN CIRCLE (*vide* index map No. 2).

18. *No. 5 Party.*—No. 5 Party surveyed an area of 5,166 square miles in the Jubbulpore, Damoh, Saugor, Narsinghpur, Seoní, Mandlá and Hoshangábád districts of the Central Provinces and in the Bhopál State of Central India; and triangulated 2,512 square miles in the Narsinghpur, Hoshangábád, Chhindwára and Betúl districts of the Central Provinces and in the Gwalior and Bhopál States of Central India. The nature of the country surveyed varied from the cultivated plains in the neighbourhood of the Narbadá River to the densely wooded slopes ascending to the Pachmarhí plateau.

19. *No. 6 Party.*—No. 6 Party surveyed an area of 3,074 square miles in the East Khándesh district of Bombay, in the Wardhá and Chánda districts of the Central Provinces, in the Yeotmál district of Berár and in the Aurangábád and Adilábád districts of Hyderábád; it triangulated an area of 3,360 square miles in the Yeotmál and Akola districts of Berár and in the Adilábád and Parbhani districts of Hyderábád, and it traversed 804 linear miles of forest boundaries and in the Santa Cruz Cantonment.

The country surveyed was of a varied nature, a large proportion being fairly open and easy: certain areas were however covered with dense scrub jungle, and here work was necessarily slow.

20. *No. 7 Party.*—No. 7 Party surveyed an area of 3,628 square miles in the North Kanara district of Bombay, in the South Kanara district of Madras, in Mysore and in Coorg, and triangulated an area of 1,769 square miles in the Coimbatore and Salem districts of Madras. The country surveyed was very varied in character; the low-lying and intricate coast line was connected by undulating ground with the high Western Ghats, beyond which was the Mysore plateau. The country was on the whole difficult to work in.

21. *No. 8 Party.*—No. 8 Party surveyed an area of 1,287 square miles in the Malabar district and in the Cochin and Travancore States of Madras, and triangulated an area of 279 square miles and traversed 84 linear miles in the

Travancore State of Madras. The country surveyed in the plains consisted of paddy fields surrounded by dense groves of palms, and in the hills, of forest which became denser as the elevation increased. Survey work was slow, laborious and expensive.

EASTERN CIRCLE (*vide* index map No. 3).

22. *No. 9 Party.*—No. 9 Party was transferred to the Eastern Circle from 1st April 1911, and triangulated an area of 3,575 square miles in the Singhbhúm district of Bengal for the detail survey of next season on the 1-inch scale. The country was for the most part hilly and covered with dense forest.

23. *No. 10 Party.*—No. 10 Party surveyed an area of 2,798 square miles in the districts of Bhamo and Myitkyiná, and in Möngmit State of Upper Burma, including 75 miles of the Burma-Yünnan frontier; 290 square miles of country beyond the frontier were sketched. 3,625 square miles were triangulated and traversed in the Kathá, Bhamo, and Myitkyiná districts. The country lay in the valley of the Irrawaddy, near the gorges of the third defile, and extended eastwards through the Kachin hills to the Chinese frontier. The hills though high and wooded were not difficult to survey, but in the low valleys heavy mist in the early morning and the thickness of the jungle delayed progress.

24. The cantonment section completed the survey of Rangoon cantonment and the mapping of all cantonments which was in hand at the close of last season; it was disbanded at the end of May 1911, having completed all the cantonment surveys that had been asked for.

25. The Land Records Training Section continued its work of giving practical training in cadastral surveying to superintendents of the Burma Land Records Department, and to probationers who had already gone through a preliminary course of instruction at Dehra Dún. The course lasted 9 months for superintendents and 12 months for probationers, during which period the pupils carried out traversing, 16-inch cadastral survey, and 64-inch town survey, as well as the computations, mapping, and area calculations involved.

26. Three surveyors of No. 10 party were attached to political missions, and carried out reconnaissance surveys of 3,735 square miles on the $\frac{1}{2}$-inch and $\frac{1}{4}$-inch scales. The work was fair-drawn during the recess, partly by the party and partly by the Simla Drawing Office.

27. *No. 11 Party.*—No. 11 Party surveyed an area of 3,229 square miles in the southern portion of the Shan States of Möng Pan and Mawkmai, and in the Karenni State of Kantaráwadi. Work lay mostly beyond the Salween and was limited towards the south and east by Siam. Triangulation was completed over an area of 1,100 square miles in Möng Pai and Mawkmai States and in Karenni, and also over 750 square miles in the Salween district.

The country was very steep, rough and rocky, communications were difficult, and inhabitants and supplies scarce. The hills were not heavily wooded except in a few patches.

28. *No. 12 Party.*—No. 12 Party surveyed an area of 3,491 square miles in the Khási and Jaintia Hills, Sylhet and Kámrúp districts of Assam, and carried out triangulation and traversing over an area of 4,040 square miles. The above area includes 26 square miles of reserved forest surveyed on the 2-inch scale. The country under survey consisted mainly of open, grassy, undulating hills with occasional pine forests; the lower slopes of these hills were as a rule thickly wooded; the remainder of the area comprised flat and cultivated plains, here and there covered with dense grass and tree jungle.

TOPOGRAPHICAL SURVEYS.

Table showing Outturns and Costs.

1910-1911.

1	2	3	4	5	6	7	8	9	10	11	12	13
Circle.	Party.	Locality.	Character of Ground.	Type of Survey.	Scale.	Outturns.		Total Outturn of Survey on all scales.	Difference from 6,000 square miles per party. (*a*)	Total cost.	Cost rate per square mile Survey and Mapping.	REMARKS.
						Survey.	Mapping.					
						Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Rs.*	*Rs.*	
N.	No. 1	Kashmir State ...	Kashmir valley to high mountains.	Survey ...	1 inch	3,514	.....	3,514	—2,486	1,10,162	31·3	Excluding Rs. 3,840 on field service press experiments.
N.	No. 2	Punjab ...	Dead level plains ...	Survey ...	1 inch	4,971	5,997	5,997	—3	1,23,724	20·6	Excluding Rs. 3,909 on special Dera Ismail Khán Survey (*b*).
			Hilly and cut up by numerous deep ravines.	Survey ...	2 inch	1,026						
N.	No. 3	Punjab and U. P. ...	Flat open country ...	Revision Survey	1 inch	5,955	6,282	6,282	+282	1,05,872	16·9	
			Delhi city and Ridge and environs.	Do. do.	2 inch	65						
				Supplementary Survey.	1 inch	262						
N.	No. 4	United Provinces ...	Plains and broken ground	Survey ...	1 inch	4,934	4,616(*b*)	6,048	+48	1,06,814(*c*)	17·7	(*b*) Area drawn but fair mapping not yet submitted. (*c*) Excluding Rs. 13,848 on cantonment surveys.
				Supplementary Survey.	1 inch	1,114						
N.	No. 9	Punjab ...	Flat open, partly desert ...	Survey ...	1 inch	3,480	.....	5,687	—313	96,277(*d*)	16·9	(*d*) Final mapping not yet completed
				Supplementary Survey.	1 inch	2,207						
			Totals, Northern Circle (*d*)	.....	...	.....	16,895	27,528	—2,472	5,42,849	19·7	
S.	No. 5	Central Provinces and Central India.	Open cultivated plains ...	Survey ...	1 inch	874	2,962	5,166	—834	1,06,642	20·6	
			Cultivated plains and wooded hills.	Survey ...	1½ inch	1,373						
				Revision Survey.	1 inch	2,919						
S.	No. 6	Bombay, Central Provinces, Berár and Hyderábád.	Dense scrub jungle ...	Survey ...	2 inch	81	3,348	3,074	—2,926	1,13,507	36·9	
			Varied ..	Survey ..	1 inch	2,223						
				Revision Survey.	1 inch	770						

S.	No. 7	Bombay, Madras, Mysore, & Coorg.	Partly open, partly hilly and wooded.	Survey ...	1 inch	734	2,926	3,628	−2,372	93,641	25·8	
			Flat open with tidal creeks	Survey ..	1½ inch	556						
			Bold, forest clad hills ...	Revision Survey	1 inch	1,783						
			Hilly forest ...	Revision Survey	2 inch	555						
S.	No. 8	Madras ...	Part flat enclosed, part hilly forest.	Survey ...	1 inch	910	2,677	1,287	−4,713	1,16,486	90·5	
			Flat enclosed ...	Survey ...	1½ inch	81						
			Part flat enclosed, part hilly dense forest.	Survey ...	2 inch	296						
			Totals, Southern Circle ...	.....	...	.....	11,913	13,171	−10,829	4,30,276	32·7	
E.	No. 10	Upper Burma ...	All densely wooded ...	Survey ...	2 inch	183	3,026(*e*) (*f*)	2,798	−3,202	1,40,146(*g*)	50·1	(*e*) Includes area surveyed the previous season. (*f*) Mapping not completed till November 1911. (*g*) Excluding Rs. 41,395 on reconnaissances and cantonment surveys (*h*).
			Partly flat and partly hilly.	Survey ...	1 inch	2,615						
E.	No. 11	Southern Shan States and Karenni.	Steep, rocky hills, lightly wooded.	Survey ...	1 inch	3,229	3,229(*f*)	3,229	−2,771	1,45,153	44·9	
E.	No. 12	Khási and Jaintia Hills and Sylhet and Kámrúp Districts of Assam.	Hilly and wooded ...	Survey ...	1 inch	2,720	3,191(*f*)	3,191	−2,809	1,50,477	47·2	
			Open plains ...	Supplementary Survey.	1 inch	445						
			Forest in hills dense in parts.	Survey ...	2 inch	26	...	...	...	...		
			Totals, Eastern Circle ...	.....	..	.....	9,446	9,218	−8,782	4,35,776	47·3	
			GRAND TOTALS ...	.....	...	.....	38,254	49,917	−22,083	14,08,901	28·2	

(*e*) The figure 6,000 square miles from which differences are shown in column 10 is the full outturn per party which it is hoped to attain in the future.

(*h*) For details see the Volume "Records of the Survey of India, 1910-11".

Table shewing progress of Topographical Surveys, 1905 to 1911.

Outturns in square miles.

Survey year.	Scale.	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1905-06	1 inch and 2 inch	5,995	1,660	10,322	17,977
1906-07	do.	7,277	7,666	8,659	23,602
1907-08	do.	14,530	9,256	12,431	36,217
1908-09	do.	17,957	12,526	11,542	42,025
1909-10	do.	23,833	12,532	9,736	46,101
1910-11	do. and 1½ inch	27,528	13,171	9,218	49,917
Areas completed to date	.....	97,120	56,811	61,908	215,839
Total areas included in topographical programme.	1 inch	620,000	542,800	528,800	1,691,600
	½ inch	130,000	.....	.....	130,000
Approximate areas remaining for Survey ...	1 inch	522,880	485,989	466,892	1,475,761
	½ inch	130,000	.....	.....	130,000

Note.—The question of reducing the scale of Survey in certain regions is under consideration. If it is found that the scale can be safely reduced for any considerable areas, the completion of the topographical programme within the settled period of 25 years from 1905 will become more probable.

II.—FOREST SURVEYS.

29. The Forest Surveys of the year were carried out, in every case, by the particular topographical parties in whose spheres of operations the forests lay. The surveys were for the most part on the 2-inch scale; but some were on the 1-inch scale, and forest boundary surveys on the 4-inch scale were carried out over a considerable area.

Northern Circle.

30. *Punjab.*—No. 2 Party surveyed an area of 219 square miles of forests, including reserved, unclassified forests, and "rakhs," in the districts of Jhelum, Attock, Sháhpur, Sialkot, and Gujrát. These were partly on the 2-inch and partly on the 1-inch scale.

31. No. 9 Party surveyed an area of 326 square miles on the 1-inch scale in the Sháhpur, Lahore, Montgomery, Gujránwála, and Lyallpur districts. The country surveyed was quite flat, and the forests consisted of open forest or scrub jungle; while in the Sháhpur district rolling sand hills predominated. No boundary traverses were run.

Southern Circle.

32. *Central Provinces.* (*Berár Circle*).—In the course of the topographical survey of Berár, No. 6 Party surveyed on the 2-inch scale 81 square miles of A, B, & C class forests falling in the Yeotmál district. The boundaries of all the above forests had previously been rigorously traversed by theodolite and plotted on the 4-inch scale. In addition 566 linear miles of theodolite boundary traverse of A, B, & C class forests were traversed in advance for next year's survey; 41 linear miles traversed last year will also be available.

Eastern Circle.

33. *Burma.*—No. 10 Party.—The following twelve forest reserves fell within the area under survey, and were surveyed on the 2-inch scale: Taungbalaung and Vya Hatha in the Myitkyiná forest division; and in the Bhamo forest division Bum Sawn, Teinthaw, Moman, Singlum, Lungyá, Kadawtaung, Si-u, Namik, Namkao, and the proposed reserves of Naunghu and Namme. The Naunghu reserve was settled so recently that traverse operations were hampered through lack of proper demarcation, and as the Namme reserve had not yet been settled or demarcated, considerable difficulty was met with, both by traversers and detail surveyors, in locating the proposed boundary. The total area surveyed by No. 10 Party amounted to 183 square miles.

34. No. 11 Party carried out 76 linear miles of theodolite boundary traverse of the Tambpak forest in the Southern Shan State of Hsa-htung.

The detail survey of this forest will be executed next year on the 2-inch scale.

35. *Eastern Bengal and Assam.*—The survey on the 2-inch scale of the Nongkyhllem reserve, situated in the Khási and Jaintia Hills division, was taken up and completed by No. 12 Party. This reserve embraces an area of 26 square miles, and contains a fair amount of Sal timber. In parts very dense and high grass jungle was encountered, which retarded the work.

III.—TRIGONOMETRICAL SURVEYS.

GEODETIC SURVEY.

(a).—Astronomical Latitudes.

36. *No. 13 Party.*—No. 13 Party was employed on latitude observations. Of the ten stations visited, six were situated in Baluchistán and Sind, Khojak being the most northerly and Sultán ka Gót near Shikárpur, the most southerly: the remaining four were situated in the Siwáliks. The results of the observations are given in the following table:—

	Station.	Height.	Longitude.	Geodetic latitude.	Astronomical latitude.	A—G.
		Ft.	° ′	° ′ ″	″	″
Baluchistán & Sind.	Khojak	7,851	66 37	30 51 24·85	20·21±0·061	−4·64
	Quetta	5,500	67 3	11 57·37	55·91±0·098	−1·46
	Mach	3,522	67 21	29 52 31·51	20·46±0·058	−11·05
	Dasti	316	67 56	0 29·93	27·61±0·058	−2·32
	Dumb	183	68 17	28 15 21·09	18·30±0·048	−2·79
	Sultán-ka-Gót	213	69 39	4 9·41	8·05±0·045	−1·36
Siwáliks.	Lachkua	2,674	78 2	30 4 34·24	5·34±0·050	−28·90
	Hatni	3,096	77 59	13 1·52	31·93±0·096	−29·59
	Bullawalla	2,432	77 49	6 51·29	22·32±0·058	−28·97
	Shorpur	2,916	77 58	13 44·43	15·30±0·073	−29·13

A negative value of (A—G) denotes a northerly attraction of the plumb-line.

37. The noteworthy features of the results are the smallness of the values of (A—G) at all the Baluchistán and Sind stations; and the equality of the values at the four Siwálik stations. There is a visible excess of mass to the immediate north of the first three Siwálik stations, and no such excess in the case of the fourth station.

(b.)—Pendulum Operations.

38. *No. 14 Party.*—No. 14 Party carried out pendulum operations in Burma, at eleven stations, fairly evenly distributed between Mogok in the north and Rangoon and Bassein in the south.

In the table below are shown the stations visited and the results obtained. The usual procedure was followed in carrying out the observations, four pendulums being swung at each place, and as a rule four complete sets of night and day observations were made, each set being preceded and followed by star observations for the determination of clock rate.

TABLE.

Stations.	Latitude.	Longitude.	Height above M. S. L.	Observed g.	Correction for Height.	Correction for Mass.	Correction for Terrain.	Corrected for Height only. g_o	Corrected for Height and Mass.	Corrected for Height Mass and Terrain. g'_o	γ_o	$g_o-\gamma_o$	$g_o'-\gamma_o$
	° ′ ″	° ′ ″	*feet.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Rangoon	16 47 55	96 9 8	164	978·467	+0·015	−0·006	0	978·482	978·476	978·476	978·434	+0·048	+0·042
Prome	18 49 40	95 13 40	101	978·543	+0·009	−0·004	0	978·552	978·548	978·548	978·541	+0·011	+0·007
Henzada	17 39 17	95 27 18	46	978·481	+0·004	−0·002	0	978·485	978·483	978·483	978·478	+0·007	+0·005
Bassein	16 47 11	94 44 6	23	978·475	+0·002	−0·001	0	978·477	978·476	978·476	978·433	+0·044	+0·043
Toungoo	18 55 50	96 27 3	159	978·558	+0·015	−0·006	0	978·573	978·567	978·567	978·547	+0·026	+0·020
Pyinmaná	19 44 25	96 11 56	409	978·578	+0·038	−0·014	+0·001	978·616	978·602	978·603	978·593	+0·023	+0·010
Meiktila	20 51 26	95 51 58	799	978·617	+0·074	−0·028	0	978·691	978·663	978·663	978·658	+0·033	+0·005
Mandalay	21 59 44	96 6 28	244	978·714	+0·023	−0·009	+0·001	978·737	978·728	978·729	978·728	+0·009	+0·001
Maymyo	22 1 13	96 28 24	3,495	978·490	+0·326	−0·122	0	978·816	978·694	978·694	978·730	+0·086	−0·036
Mogok	22 54 51	96 29 51	3,685	978·539	+0·343	−0·129	+0·003	978·882	978·753	978·756	978·787	+0·095	−0·031
Myingyan	21 28 56	95 23 50	248	978·690	+0·023	−0·009	0	978·713	978·704	978·704	978·696	+0·017	+0·008

TRIANGULATION (*vide* index map No. 12).

39. The work of No. 15 Party included principal and secondary triangulation and the selection of sites for base lines.

(a).—Principal Triangulation.

(i).—The Upper Irrawaddy Series was continued from the side Marau-Matu Bum in a northerly direction up to parallel 25° 30′, where it bent eastward. Owing to bad weather conditions, the intention of making a junction with the Mandalay meridional series has had to the postponed (*vide* index chart Great Trigonometrical Survey).

(ii).—The Great Salween Series. Work on this series had been in abeyance since April 1909. It was continued this season from the side Loi Lung—Loi Danwa, first easterly and then south-easterly, following the eastern boundary of Burma.

(iii).—The Kashmír Principal Series was extended from the base Chotiwála—Ratha Pahar towards the north. After completion of the triangulation, reconnaissance was carried out, to decide on the route by which the Indian triangulation should be joined up with that of Russia. Three routes were examined, and the one selected was through the Hunza valley.

(iv).—Revision of heights on the Great Arc Series. Some discrepancies of heights having been found to exist on this series, it was decided to commence a revision of all stations south of latitude 24°. Obervations were carried out at 12 stations and the heights of 10 old ones revised.

In addition 3 of the stations which were found to have been destroyed were rebuilt.

(b).—Secondary Triangulation.

(v).—The Mawkmai Series running through the Southern Shan States was completed during the year; it closed on the Monghsat Secondary Series.

(vi).—The Gáro Hills Series emanates from the Brahmaputra Meridional Series and was intended to be a westward extension of the Khási Hills Series. Owing, however, to bad weather and sickness, the junction was not effected.

(vii).—The Jaintia Hills Series is a continuation of the Khási Hills Series eastward.

(viii).—Secondary work in Kashmír. In order to locate the peak Teram Kangri and to determine its height, a short length of triangulation has been run from Montgomerie's Kashmír Series, northwards up the Nubra valley.

This triangulation places Teram Kangri 3 miles south-east of the position assigned to it by Dr. Longstaff. The height obtained from observations of vertical angles is approximately 24,500 feet, and is smaller than Dr. Longstaff's value by over 2,000 feet.

(c)—Base Lines.

(ix).—Two sites for the measurements of base lines were selected and prepared, one near Bhamo about 9 miles along, and another at Prome 13 miles long.

ABSTRACT OF TRIANGULATION.

	Principal.			Secondary.		
	(i) Upper Irrawaddy.	(ii) Great Salween.	(iii) Kashmír principal.	(v) Mawkmai.	(vi) Gáro Hills.	(vii) Jaintia Hills.
No. of Stations observed at ...	8	5	4	15	11	24
,, ,, newly fixed ...	4	4	4	11	9	23
,, ,, provisionally fixed ...	4	3	2	...	...	...
,, ,, built	5	6	2	1	12	..
Length of triangulation completed in miles.	80	74	64	58	60	78
Area of triangulation in sq. miles ...	1,760	2,200	680	500	763	473
Average triangular error ...	0″·875 for 10 triangles.	0″·753 for 9 triangles.	0″·606 for 8 triangles.	2″·44 for 18 triangles.	1″·57 for 6 triangles.	1″·36 for 23 triangles.
No. of Astronomical azimuths observed.	1	1	0	...	...	...

TIDAL OPERATIONS.

40. *No. 16 Party.*—Observations were taken by means of self-registering tide-gauges during the year, at the stations enumerated in the following list:—

	Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1	Aden	1879 ...	Still working	32	
2	Karáchi ...	1868 ...	1880	*13 } 44	* Small tide-gauge.
		1881 ...	Still working	31 }	
3	Bombay (Apollo Bandar) ...	1878 ...	Still working	33	
4	Bombay (Prince's Dock) ...	1888 ...	Still working	23	Property of Port Trust.
5	Madras ...	1880 ...	1890	10 } 26	
		Restarted 1895	Still working	16 }	
6	Kidderpore	1881 ...	Still working	30	
7	Rangoon	1880 ...	,,	31	
8	Port Blair	1880 ...	,,	31	
9	Moulmein ...	1880 ...	1886	6 } 8	
		Restarted 1909	Still working	2 }	

41. In addition to the above, readings to tide-poles were taken at Bhávnagar, Chittagong, and Akyab.

42. The 9 tidal observatories at work were inspected during the year, and the registrations have been satisfactory.

43. In the following tables are given the annual and decadal percentages of the predicted time and height errors of high and low waters at open coast and riverain stations.

Percentage of errors in Predicted Times and Heights at open coast stations from Automatic Registrations.

Year.	Number of stations.	In Time. Within 15 minutes of actuals.		In Height. Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
1905	7	82	79	96	95	96	97
1906	6	85	81	96	97	94	95
1907	6	84	83	98	98	98	99
1908	6	84	84	98	97	99	99
1909	6	85	86	97	97	97	98
1910	6	81	83	98	98	95	96
Average of 10 years	.....	81	78	96	96	96	96

Percentage of errors in Predicted Times and Heights at riverain stations from Automatic Registrations.

Year.	Number of stations.	In Time. Within 15 minutes of actuals.		In Height. Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
1905	2	52	62	72	57	94	92
1906	2	59	53	74	64	92	95
1907	2	58	47	78	60	96	90
1908	2	58	52	77	60	97	92
1909	3	61	59	69	65	93	92
1910	3	57	52	63	71	89	94
Average of 10 years	.....	57	57	72	61	93	92

LEVELLING OPERATIONS.

44. *No. 17 Party.*—Three detachments were employed as in the preceding years.

(i). No. 1 was employed in the Bombay Presidency, between Bombay and Dhárwár; its outturn amounted to 376 miles, and it laid down and connected 114 benchmarks. The circuit Mormugao, Belgaum, Hubli, Kárwár, Mormugao was completed, closing with an error of ·308 feet.

(ii). No. 2 detachment levelled from Gauhati to Dibrugarh and from Gauhati to Dumpep. The total length levelled was $362\frac{3}{4}$ miles, and the heights of 111 benchmarks were determined.

(iii). No. 3 levelling detachment was employed on levelling from Ambála to Solon in the Himalayas, from Dera Ismail Khán to Chunda on the Bannu Road, from Dargá Khán *viâ* Rawalpindi to Murree, and from Nowshera to Risalpur cantonment. The outturn amounted to 408 miles, and 107 benchmarks were connected.

45. Bench-marks have now been fixed on the Lesser Himalayan Range on seven different lines: namely—

Tindharia,	Mussoorie,
Naini Tal,	Solon,
Lansdowne,	Dharamkot,

Murree,

and the new line from Dera Ismail Khán to Chunda gives a valuable connection with the Trans-Indus mountains.

MAGNETIC SURVEY.

46. *No. 18 Party.*—Four detachments, each under a Provincial officer, were employed.

47. One detachment was employed in re-observing a number of selected old field stations, the sites of which were permanently marked for future occupation. A second detachment carried out a detailed survey of the Bengal coal field, in response to numerous requests for accurate values of magnetic declination. The third detachment had been allotted to the magnetic survey of the Andaman and Nicobar Islands, for which the census operations appeared to offer a favourable opportunity. The arrangements, however, fell through, and after observing at Port Blair and 3 new stations in the Andamans, the detachment was employed on detail survey in Bengal. The fourth detachment was employed on office duties during the cold season and proceeded to Kashmír in April 1911. 29 new stations were observed, the detachment returning to recess in July.

48. The officer in charge observed at 22 repeat stations and made comparative observations at the 4 survey base stations and at Alibag magnetic observatory. During the season full sets of magnetic observations were taken at 109 new stations, while 56 old field stations and 23 repeat stations were re-occupied.

49. *Work during recess.*—The computation of the previous season's field work and the reduction and tabulation of the base station results for 1910 have been completed. The computation of a new series of selected quiet days, for which traces are available at all the survey base stations, has also been completed.

The investigation of the instrumental differences from the standard in H. F. has been continued but is not yet completed.

50. The mean values of the magnetic elements at the various observatories for 1910 are as follows:—

Observatory.	Latitude.	Longitude.	Dip.	Declination.	H. F.	V. F.
	° ′ ″	° ′ ″	° ′	° ′	C. G. S.	C. G. S.
Debra Dún ...	30 19 19	78 3 19	N 43 54·8	E 2 31·9	·33257	·32019
Barrackpore ...	22 46 29	88 21 39	N 30 42·2	E 0 55·5	·37329	·22168
Toungoo ...	18 55 45	96 27 3	N 23 2·1	E 0 24·9	·38801	·16498
Kodaikánal ...	10 13 50	77 27 46	N 3 45·2	W 0 55·0	·37485	·02459

PART III.

OFFICE WORK.

I.—HEADQUARTERS OFFICES.

MAP PUBLICATION (*vide* index maps at end).

51. The classes of maps for the publication of which the office is responsible may be enumerated as follows:—

(a)—The map of India on the scale of 1 inch=1 mile.
(b)—The map of India on the scale of $\frac{1}{4}$ inch=1 mile.
(c)—Geographical maps on the one-millionth scale.
(d)—Small scale geographical maps.
(e)—Special maps.

52. The first duty of the office is to reproduce and print the 1-inch and $\frac{1}{4}$-inch maps of India, prepared by the field parties and circle offices from the topographical surveys now in progress.

53. *(a) The map of India on the scale 1 inch = 1 mile.*—During the year 111 sheets of the new 1-inch map have been received from Circle Offices for publication, and 115 have been reproduced and printed.

54. Index maps Nos. 4, 5, and 6 at the end of this report show the progress of the publication of the 1-inch map, and the table below gives the annual outturn of its sheets since the modern survey was begun.

TABLE.*

Year.	Standard Sheets Printed.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1905-06	...	...	...	...
1906-07	4	1	...	5
1907-08	16	13	22	51
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
Total printed ...	178	133	184	495
Total in programme ...	2,160	2,067	2,101	6,328
Number remaining for publication ...	1,982	1,934	1,917	5,833

55. In addition, 30 sheets based on revenue surveys or on topographical surveys executed before 1st October 1905 have been received from the Northern Circle and Bengal Drawing Office for publication and 26 have been published as preliminary editions in modern form during the year, *vide* index maps Nos. 7, 8, and 9.

56. To maintain the existing stock of 1-inch sheets, or to give effect to important alterations due to the development of communications, 114 sheets on the 1-inch scale have been reprinted with minor alterations.

57. *(b) The map of India on the scale of $\frac{1}{4}$ inch = 1 mile.*—Of the sheets of the new $\frac{1}{4}$ inch map of India in "degree sheet" form, only two were received for publication in 1910-11; both of these required certain references and alterations and could not be published before the close of the year, *vide* index map No. 10.

* The figures shown in the similar table on page 20 of the General Report for 1909-10 have been altered as certain sheets had been omitted from that report.

58. Each "degree sheet" includes the area covered by 16 one-inch sheets, and its preparation is necessarily delayed until the component 1-inch sheets are available. A considerable number of the sheets are however now in course of preparation in the circle offices, and material for the preparation of all degree sheets of which the component 1-inch sheets have been received, has been supplied to the circle drawing offices.

59. Pending the preparation of the new map, 16 sheets on the scale of $\frac{1}{4}$ inch = 1 mile have been prepared and published at headquarters from the maps of old surveys. Five of these were printed during the year.

60. (*c*) *Geographical maps on the one-millionth scale.*—Next to the duty of publishing the immediate results of the topographical surveys, the most important work of the offices consists in the preparation of the Map of India and Adjacent Countries on the scale of $\frac{1}{1,000,000}$ and of the general small-scale maps.

61. Index map No. 11 at the end of this report shows the progress made as regards the $\frac{1}{1,000,000}$ sheets; four new sheets have been published and reprints with minor alterations made of six sheets.

62. (*d*) *Small scale Geographical maps.*—A new "Railway, Road and Canal Map of India" on the scale of 32 miles = 1 inch has been prepared and published at the instance of the Railway Board. It was based upon the fourth edition of the Map of India and Adjacent Countries (32 miles = 1 inch).

63. The compilation and engraving of the new Map of India and Adjacent Countries on the scale of 32 miles = 1 inch has made fair progress. As mentioned in last year's general report, the decision to include Tibet and other north-eastern areas has necessarily postponed the completion of the map, but 11 out of the 12 sheets are now almost finished.

64. The new engraved index maps are in hand; of 42 which cover the Indian area two have been completed during the year, and twenty are being compiled and engraved, leaving eighteen still to be taken up.

65. (*e*)—*Special Maps.*—A large number of special maps have been prepared for the different departments of the Indian Government. Among these may be mentioned the new 64-mile Railway Administration Map which will be revised and published annually and a railway map for the Coronation Durbar, of which 150,000 copies were printed.

66. Towards the close of the year several maps for census purposes and a considerable number of maps and plans for the Coronation Durbar have been put in hand.

DRAWING AND ENGRAVING OFFICES.

67. These offices have made fair progress in the compilation, drawing, examination and engraving of the geographical maps and special maps.

68. The drawing office dealt with 97 one-inch and $\frac{1}{4}$-inch modern sheets which required slight additions or corrections before publication, and prepared 150 old 1-inch and $\frac{1}{4}$-inch sheets for reprinting.

69. Among the maps, the engraving of which has been completed during the year, are the plans of Calcutta on the scale of 6 inches=1 mile, in four sheets.

70. The number of copper-plate impressions pulled has been 36,432, and the electrotype section has dealt with 247 plates.

PHOTO-LITHO. OFFICE.

71. The experiments with three-colour photography as described in last year's report are still in progress. It is believed that the method may prove of use in the production of "layered" maps, which show heights above sea level by means of layers of different shades of colour.

72. During the year only 141 sheets in modern standard form were published; this is a decrease of 75 from 1909-10. The decrease was due to a falling off in the number of sheets received from circle offices for publication, which accounts for the diminished outturn of the office.

73. There has been a small increase in the number of extra-departmental maps, &c., received for publication, but the office could still deal with a considerably larger number.

The office sent an exhibit to the United Provinces Exhibition at Allahabad during the cold weather and was awarded the 'Grand Prix' for "Photo.-mechanical Printing Processes and Maps."

74. The following table shows the cost and outturn of the office for the past three years:—

1	2	3	4	5	6	7	8
Year.	Cost of office.	Value of outturn at cost rates.	Recovered in cash or by book debit.	Number of impressions pulled.	Number of maps printed.		
					Departmental.	Extra departmental.	Total.
	Rs.	*Rs.*	*Rs.*				
1908-09	158,643	172,234	42,531	1,506,667	2,047	726	2,773
1909-10	154,494	213,894	51,586	1,574,180	2,697	1,053	3,750
1910-11	164,193	177,900	50,693	1,383,147	2,559	1,104	3,663

MAP RECORD AND ISSUE OFFICE.

75. The gross face value of the maps received from the printing offices during the year amounted to Rs. 2,27,431. This sum includes Rs. 16,214-8-0 and Rs. 15,238-8-0, the values of maps printed in the Engraving Office and at Dehra Dún respectively.

76. The following table shows the maps printed and received and their face values.

Class of maps.	Scale.	Number of different maps of each class received.		Value.
		New publications and New Editions.	Reprints.	
				Rs.
Geographical maps	Small	3	2	8,985
India and Adjacent Countries ...	$\frac{1}{1,000,000}$	6*	6	4,700
Degree sheets, &c.	1 inch = 4 miles	24	.....	10,200
Standard sheets (in modern form)...	1 inch = 1 mile	141	.....	17,469
Provincial maps	1 inch=16 miles 1 inch=32 miles	.....	1	1,850
District maps	1 inch = 4 miles	6	4	3,300
Atlas sheets	1 inch = 4 miles	.....	168	26,461
Standard sheets (old style) ...	1 inch = 1 mile	29	85	47,245
Administration Report maps ...	1 inch = 8 miles	.....	34	553
Plans of Cities and Cantonments ...	Various	15	5	15,755
Triangulation and traverse charts...	Various	44	.....	1,120
Index maps	Various	12	4	1,690
Miscellaneous maps	Various	256	16	24,103
Totals for 1910-11 ...	.....	541	325	2,17,431
Corresponding totals for 1909-10	.....	482	412	3,40,000

* Includes engraved editions of two sheets formerly published as helio'd editions.

77. The total number of printed maps issued during the year was 2,30,948 of an aggregate value of Rs. 1,27,167. The details of the sales were as follows :—

Sales to	Number of maps.	Value.
		Rs.
Government officials	151,790	46,628
India Office	2,468	3,509
Departmental issues	39,580	46,772
Private individuals	31,661	23,834
Agents	5,449	6,424
Totals for 1910-11 ...	230,948	1,27,167
Corresponding totals for 1909-10 ...	142,421	1,24,858

MATHEMATICAL INSTRUMENT OFFICE.

78. During the last year there was an increase in the demands made by Government departments on the store and workshop sections into which this office is divided. The result of the increased demand is that the store section shows a loss of Rs. 6,891 as compared with a loss of Rs. 20,176 last year and the workshop section shows a profit of Rs. 10,673 as compared with a loss last year of Rs. 15,270.

79. It must be borne in mind that this office is some what similar to a retail establishment with the difference that it issues stores to Government departments at their net value and in its yearly profit and loss account it takes as a credit 25 per cent. of the value of the stores issued, whereas a commercial firm would charge double this percentage in order to cover the costs of supervision, rent, interest or plant and stores, depreciation and clerical labour. The Mathematical Instrument Office therefore in its yearly profit and loss accounts shows a total loss or profit according to whether the demands made on it by Government departments have been small or great, as the percentage charged on the net value of the stores issued are not sufficient to cover the standing charges in bad years. A full statement of the accounts is given in the Volume "Records of the Survey of India, 1910-11."

80. A new price list revised and corrected up to April 1st, 1911 has been issued.

Apart from ordinary repairs and manufactures, the following special works were completed :—

(1) A metal stand for a new 36″×36″ camera.

(2) A transparency carrier for use with the above camera.

(3) A new system of collimating and adjusting of telescopes and binoculars has been finally introduced during the year, and has proved satisfactory.

(4) A second small motor has been attached to the scale dividing machine, to drive a small circular saw of fine gauge, as a substitute for the ordinary point dividing tool. This has proved very successful.

(5) A light field litho. press was designed and constructed. It has been favorably reported on but has not yet been finally sanctioned.

II.—DEHRA DÚN OFFICES.

SPECIAL OPERATIONS.

81. During the year the building for the base line observatory and seismograph house was completed. The main part of the building now awaits the arrival of the new standards and comparators from England. In a smaller room an Omori horizontal pendulum seismograph has been installed; but considerable difficulty has been met with in the working of this instrument owing to its extreme sensitivity. It is hoped though that when a proper protective case, to keep off air currents and insects, has been fitted, it will prove satisfactory. The zero of the instrument so far has not remained steady.

82. The clockwork for rotating the drum did not work well, and a tide-gauge clock has now been fitted with satisfactory results. Records are now being taken daily and several small earthquakes have been recorded.

83. Photographs of the sun were taken on 328 days of the year, the sun being obscured by clouds on the remaining days.

84. Meteorological observations have been continued throughout the year.

COMPUTING SECTION.

85. The chief points of interest in the work of this section are as follows:—

Geodetic work.

86. The final deduction of heights of all bench-marks in India has been completed and the results incorporated in Volumes XIX. A and XIX. B. These volumes together with Volume XIX have been distributed. The preparation of pamphlets giving all bench-marks falling in 4°-squares of latitude and longitude has been taken up, and two of these pamphlets have been completed and distributed.

87. Mr. Shaw's Professional Paper on Refraction has been printed.

Geographical work.

88. Numerous computations in connection with Trans-Frontier Degree Triangulation Charts have been made, and Captain Robinson's triangulation computations have been completed.

89. A large amount of topographical triangulation has been adjusted.

90. Barometric heights and latitudes observed by several travellers and explorers have been worked out.

91. Papers on Rectangular Co-ordinates by Mr. Eccles, and on Barometers by Mr. Hunter have been printed, and tables computed for them. Experimental computations in connection with refraction and with the variation of magnetic elements with geographical position have been made.

Preservation of trigonometrical stations.

92. 924 Stations were repaired by the district officers at a cost of Rs. 5,724-1-11. Out of 340 districts from which reports are annually due, 11 failed to make returns.

DRAWING SECTION.

93. The following table shows the volume of work undertaken :—

Class of map.	Number of sheets in hand.	Number of sheets drawn and sent to press.
Scientific diagrams and charts	*Nil*	2
Geographical maps, $\frac{1}{1,000,000}$ scale	5	2
Do. do. smaller scale	2	0
Miscellaneous indexes and plans	6	13
Triangulation Charts	42	71
Levelling Charts	8	2
Special maps for Doctor Stein	17	77
Total ...	80	167

PHOTO.-ZINCO. SECTION.

94. 1,844 maps and diagrams were photographed, against 1,750 in 1909-10. The number of impressions pulled was 294,118 against 302,909 in the previous year. The lithographic machine was employed throughout the year printing the maps of Doctor Stein's exploration, cantonment maps, forest maps, and triangulation and levelling charts.

FOREST MAP OFFICE.

95. The number of maps issued to Forest and other officials and to the public during the year was 17,312, which is an increase of 7,750 over last year. The amount realized by sales amounted to Rs. 1,724 against Rs. 1,555 in the previous year. Of this amount Rs. 1,060 was adjusted by book debit and Rs. 664 accrued from sales to private individuals and trading companies.

96. The following table shows in abstract form the work dealt with by the office:—

Class of map.	Number of Sheets.		
	In hand.	Drawn and sent to press.	Published.
Standard maps of Forest Surveys	96	33	74
Special maps of India...	.....	.....	3
Provincial, Divisional, and District Forest maps ...	16	4	5
Working Plans and Miscellaneous maps ...	.....	3	5
Total ...	112	40	87

III.—CIRCLE AND LOCAL DRAWING OFFICES.

NORTHERN CIRCLE DRAWING OFFICE.

97. The normal main work of the office was the examination of standard sheets drawn by the various parties, the drawing and examination of sheets which the parties (either from insufficient establishment or owing to a short recess season) had been unable to undertake, the preparation of special editions of standard sheets, and the drawing of degree sheets. The office also undertook the drawing of certain sheets of the $\frac{1}{M}$ series, until the 1st of January when they were made over to the Simla Drawing Office; and the examination of standard sheets prepared in the United Provinces Drawing Office.

98. The following is a summary of the work in hand and sent to press :—

Class of map.	Scale.	Number of Sheets.	
		In hand	Sent to press.
Standard sheets	1 inch = 1 mile	30	71
Degree sheets	1 inch = 4 miles	10	2
Miscellaneous maps	390 feet = 1 inch	1	2
Cantonment maps	16, 64, 48 & 12 inch	3	8

UNITED PROVINCES DRAWING OFFICE.

99. This office, also under the Superintendent, Northern Circle, continued its work of compiling and drawing 2-inch standard maps, for reduction to 1-inch, from old cadastral surveys, and in preparing traverse charts. Sheets were drawn in both the old and new styles. In all 19 sheets were compiled and submitted for publication, and 26 traverse charts were completed. 7 standard sheets and 21 traverse charts remain to be completed.

SOUTHERN CIRCLE DRAWING OFFICE.

100. The final examination of 35 standard sheets was completed, and the fair drawing of 6 degree sheets was commenced. Considerable assistance was given to the parties, with a view to enabling them to complete their current mapping.

101. The Photo.-zinco. section undertook all the photographic and Vandyke work required by the parties.

EASTERN CIRCLE DRAWING OFFICE.

102. This office was formed at the commencement of the season under report, having hitherto formed part of what is now the Southern Circle Drawing Office. It was transferred from Bangalore to Shillong in September 1910.

103. The following table shows the work performed during the year. Owing to the large number of 1-inch standard sheets submitted in an unfinished state by the field parties, and to the want of sufficient trained establishment, the mapping of degree sheets has been in abeyance.

Standard sheets, &c., received from field parties, surveyed in season 1909-10.

	No. of Party.	Complete.	Incomplete.	Total.	Drawn in D. O.	Forwarded to Calcutta for Publication.	Remarks.
Standard sheets.	10	9	8	17	.....	12	
	11	5	8	13	3	9	
	12	2	9	11	.....	8	
	Totals ...	16	25	41	3	29	

BENGAL DRAWING OFFICE.

(Standard Mapping Section).

104. The standard mapping section of this office continued its work of compilation of standard sheets from modern cadastral surveys for publication as preliminary editions.

105. 79 standard sheets were dealt with, and 25 have been sent for publication. Of these 16 were compiled specially for supplementary survey by No. 9 Party during the coming field season.

106. A certain amount of work was done for the Map Publication Office, namely:—

(*a*) Fiscal limits and cultivation were colored on 19 black prints;

(*b*) 9 uncorrected proofs were examined and corrected;

(*c*) 15 published proofs of standard sheets not printed in colours were coloured as office copies.

PART IV.

WORK FOR OTHER GOVERNMENT DEPARTMENTS.

107. As usual during the year much special work was done for other departments. Instances already mentioned in this report are:—Forest Surveys (page 13), Riverain work in the Punjab (page 8), Cantonment Surveys (pages 7, 8, 9, 27).

The Mathematical Instrument Office supplies and repairs certain classes of instruments for every Government department in India including the Army Department.

108. Surveyors from several parties were attached to missions on the North-western and Eastern frontiers, and executed reconnaissance surveys for the Foreign and Army Departments.

109. In Travancore State the Periyár catchment area was surveyed for irrigation purposes on the 2-inch scale.

110. The reproduction for other departments of maps, plans and illustrations that do not require redrawing, does not interfere with the normal work of the Survey of India and is always undertaken when asked for. On the other hand the amount of drawing and compilation that can be done for extra-departmental purposes is limited and is necessarily confined to urgently required and important maps.

111. During the year special drawing and compilation has been done for the following:—

The Government of India, chiefly for the Foreign Department.

Local Governments.

The Chief of the General Staff.

The Coronation Durbar Committee.

The Railway Board.

The Census Commissioners and Local Census Superintendents.

The Post Master General.

The Director of Meteorological Observatories.

Maps, plans, or illustrations were reproduced for the following in addition:—

The Forest Department.

The Department of Agriculture.

The Government Architect.

The Sanitary Commissioner with the Government of India.

The Geological Survey.

The Telegraph Department.

The Military Works Services.

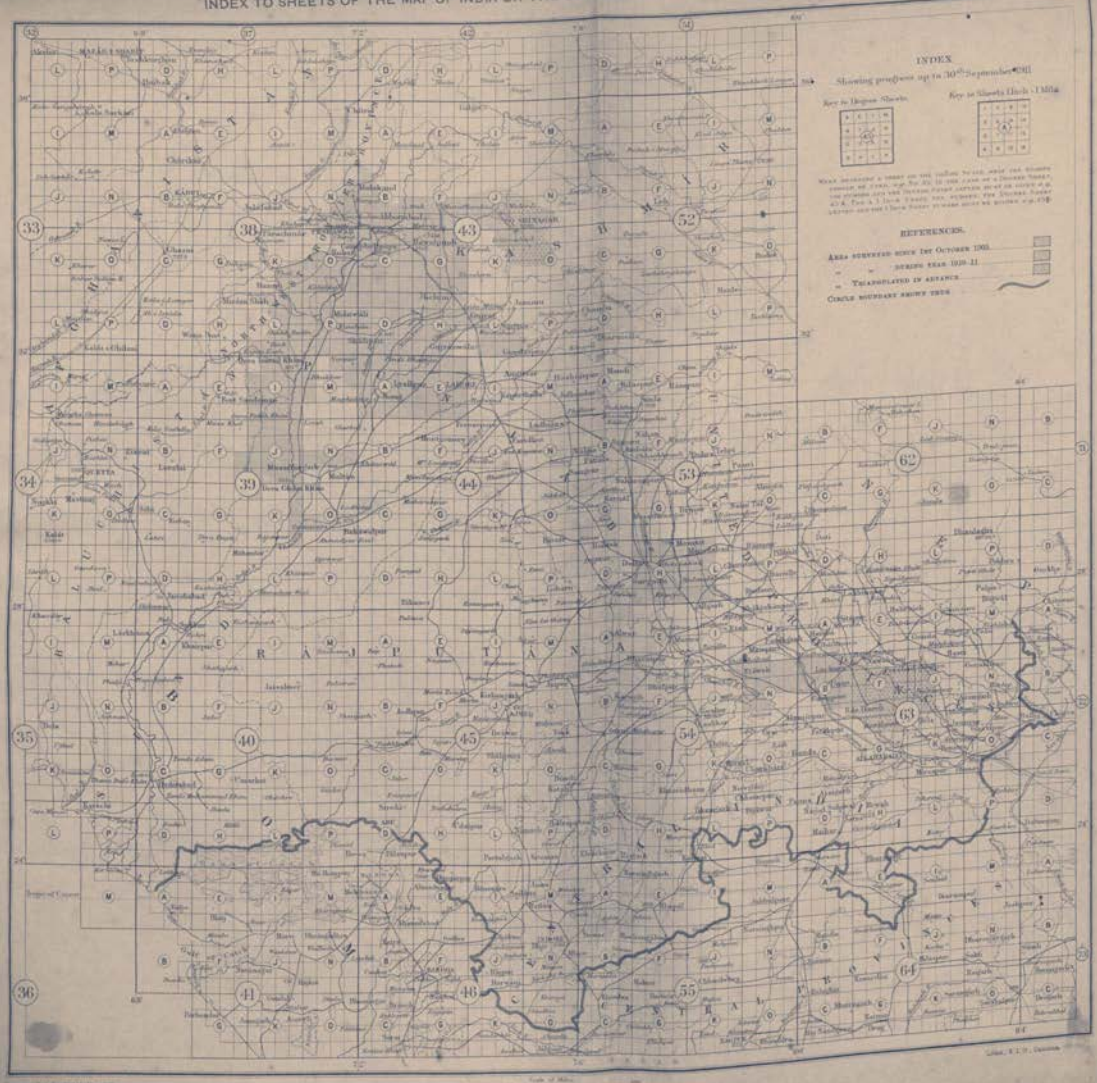
The Indian Museum.

112. Some work was also done for societies such as the Astronomical Society of India, the Asiatic Society of Bengal and the Photographic Society of Bengal.

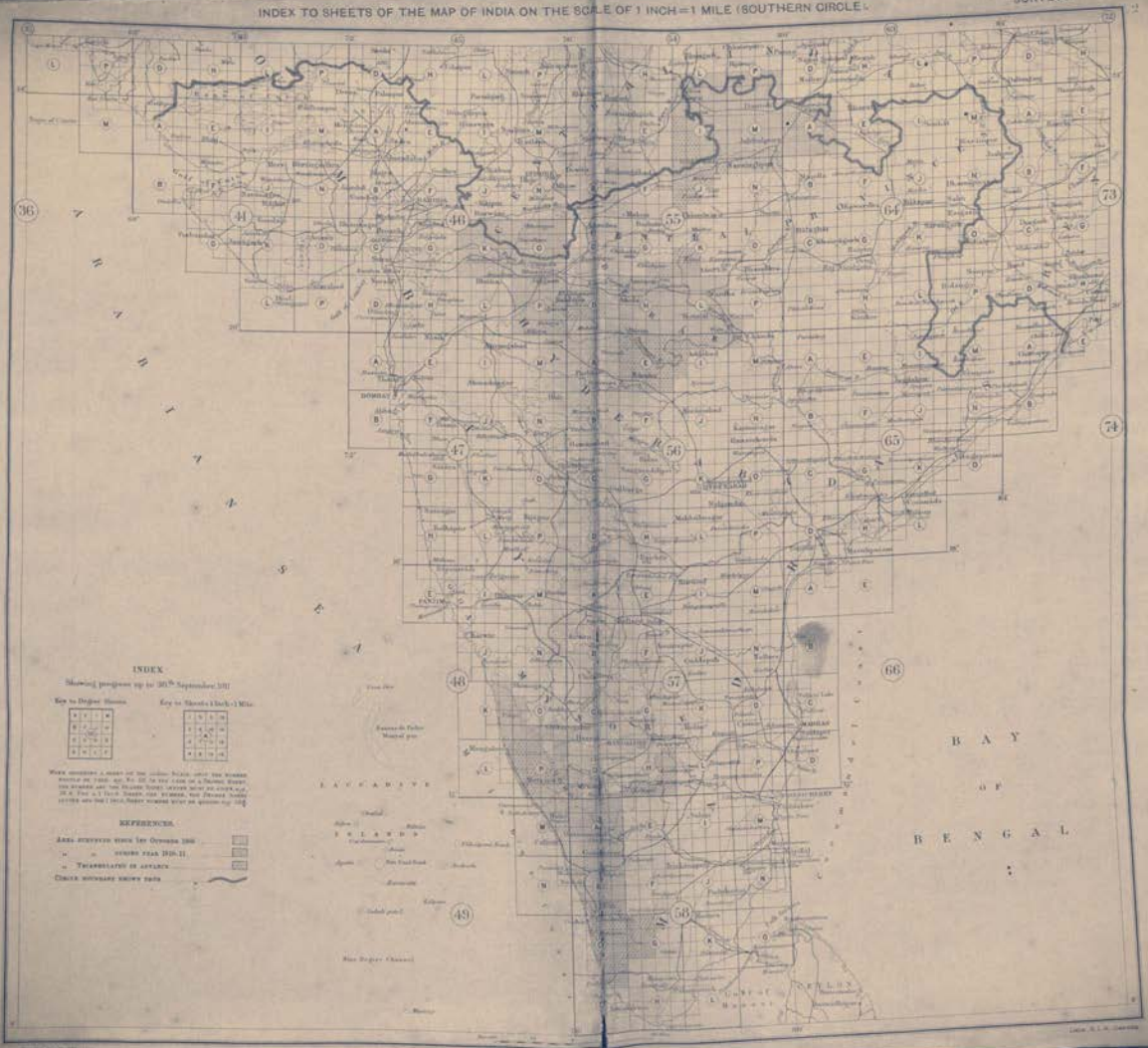
113. The preparation of the maps on the scale of 4 miles = 1 inch of Dr. Stein's explorations in Chinese Turkestan and Western China, 1906—08, is in hand at Dehra Dún.

114. A section of the Simla Drawing Office is employed solely on miscellaneous work for the Chief of the Staff, and has turned out a large number of maps and sketches.

INDEX TO SHEETS OF THE MAP OF INDIA ON THE SCALE OF 1 INCH = 1 MILE (NORTHERN CIRCLE).



INDEX TO SHEETS OF THE MAP OF INDIA ON THE SCALE OF 1 INCH = 1 MILE (SOUTHERN CIRCLE).



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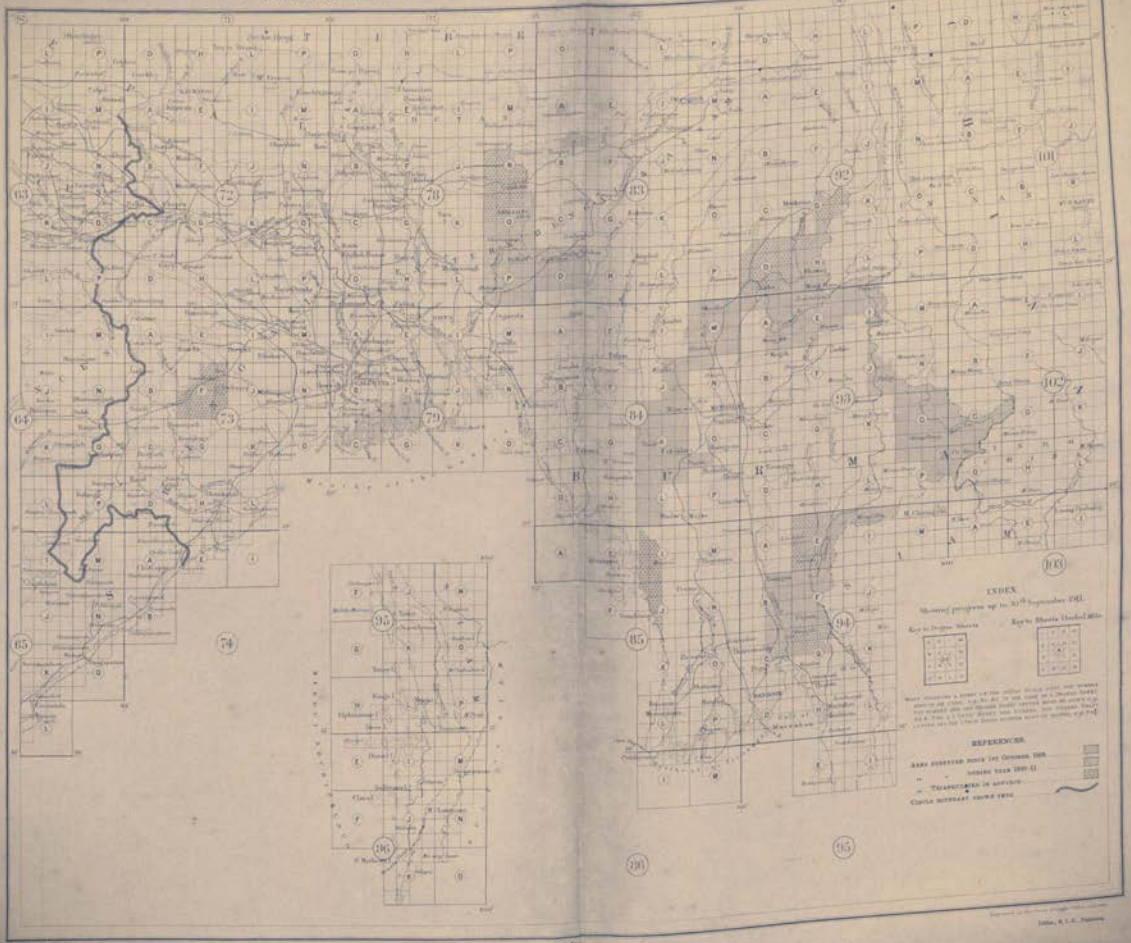

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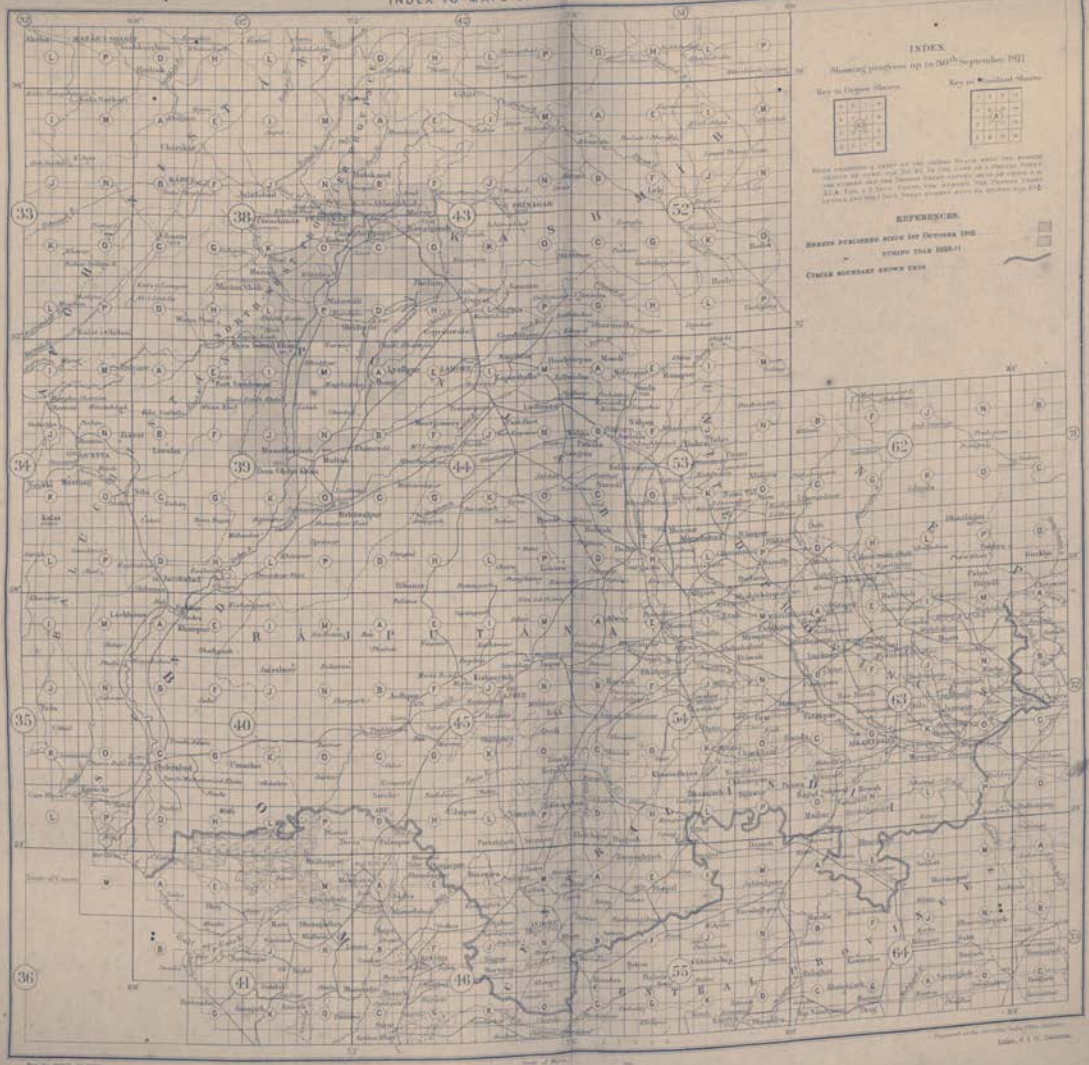
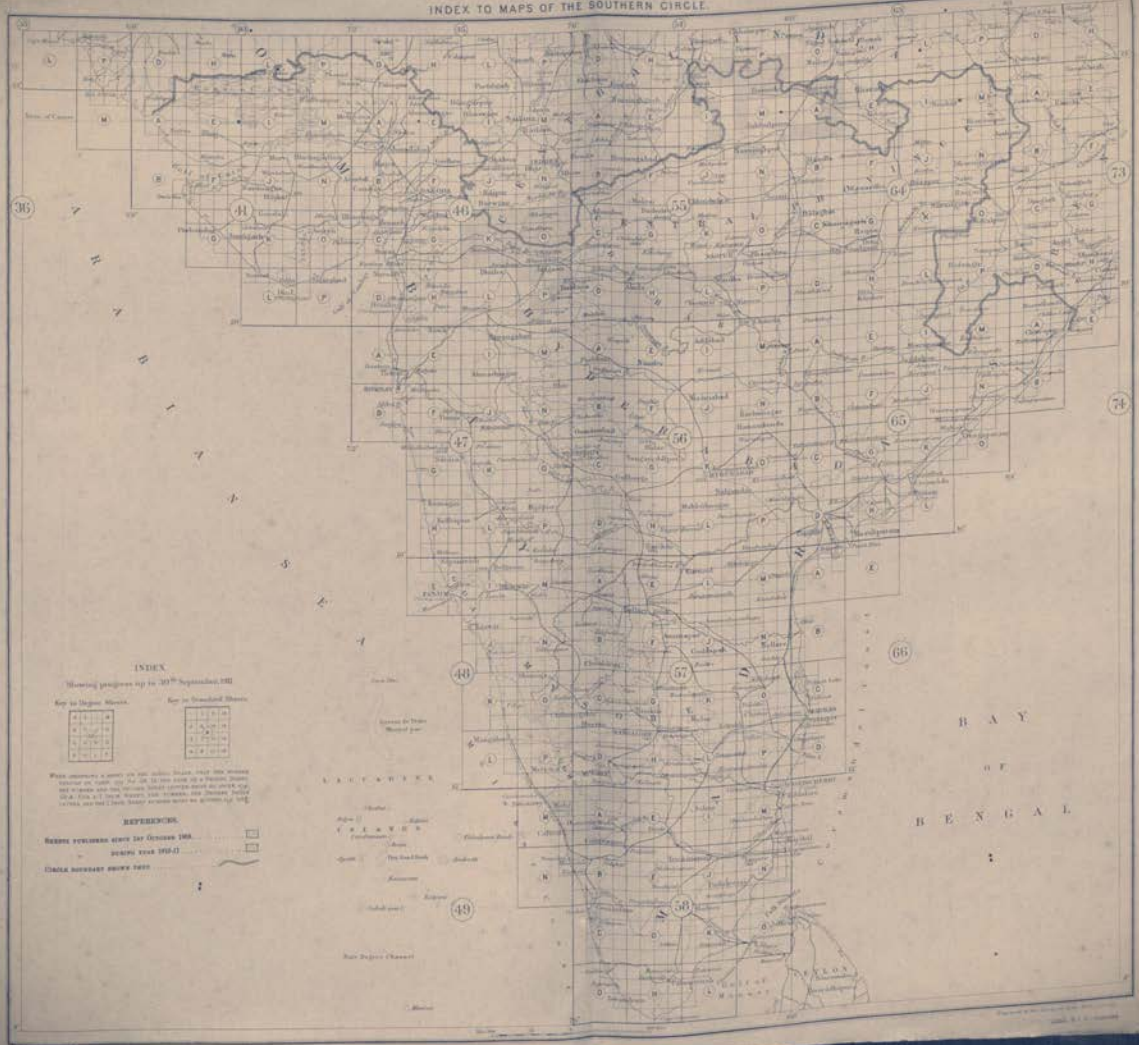
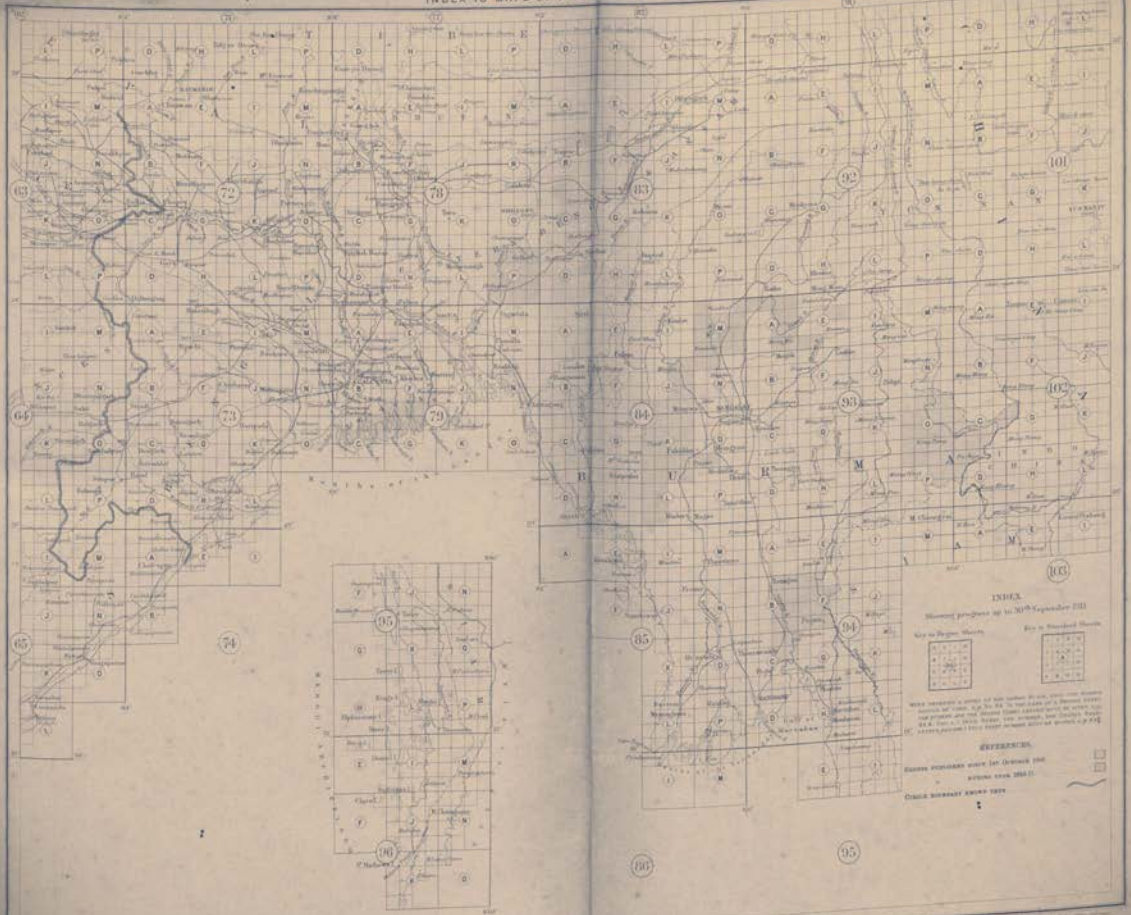


INDEX TO MAPS OF THE SOUTHERN CIRCLE.



INDEX TO MAPS OF THE EASTERN CIRCLE.



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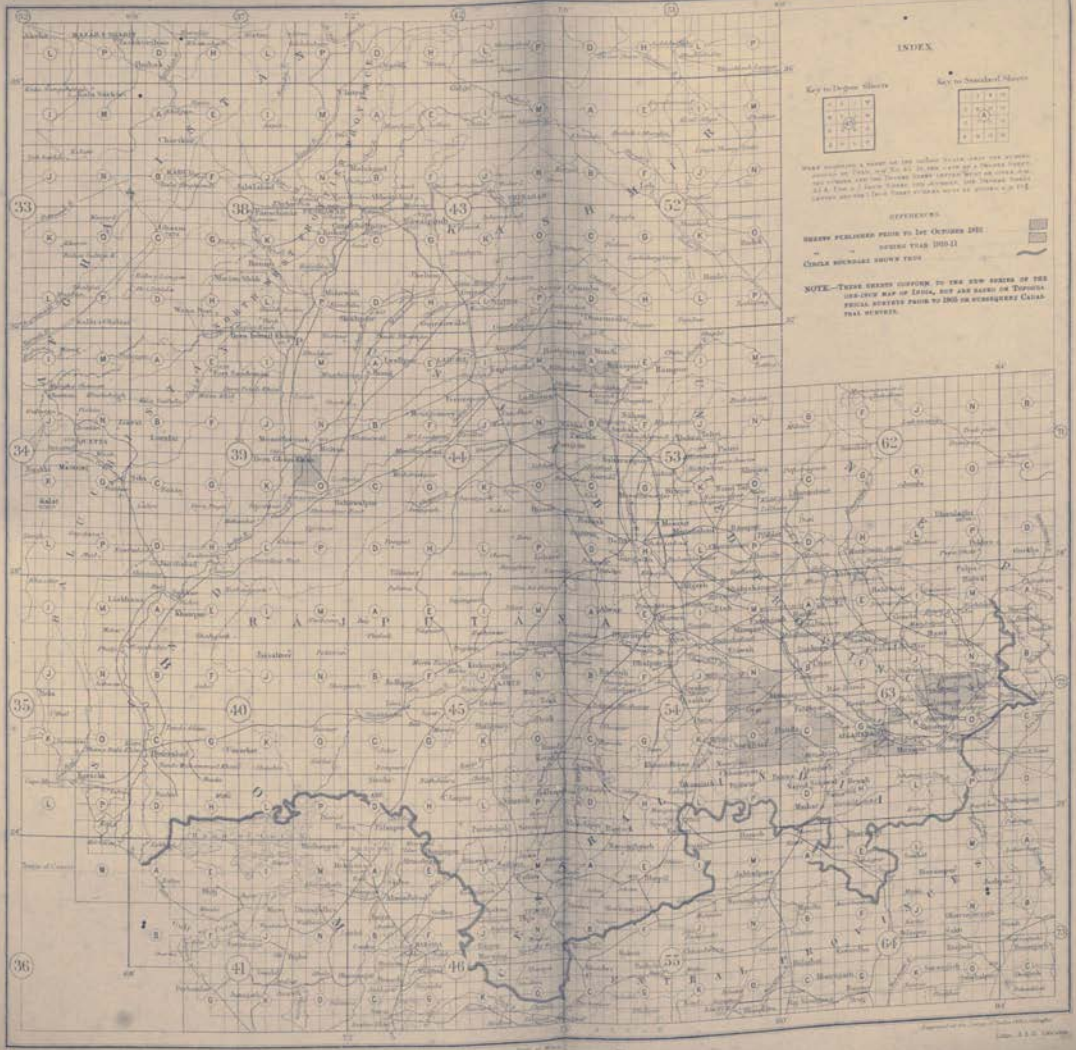

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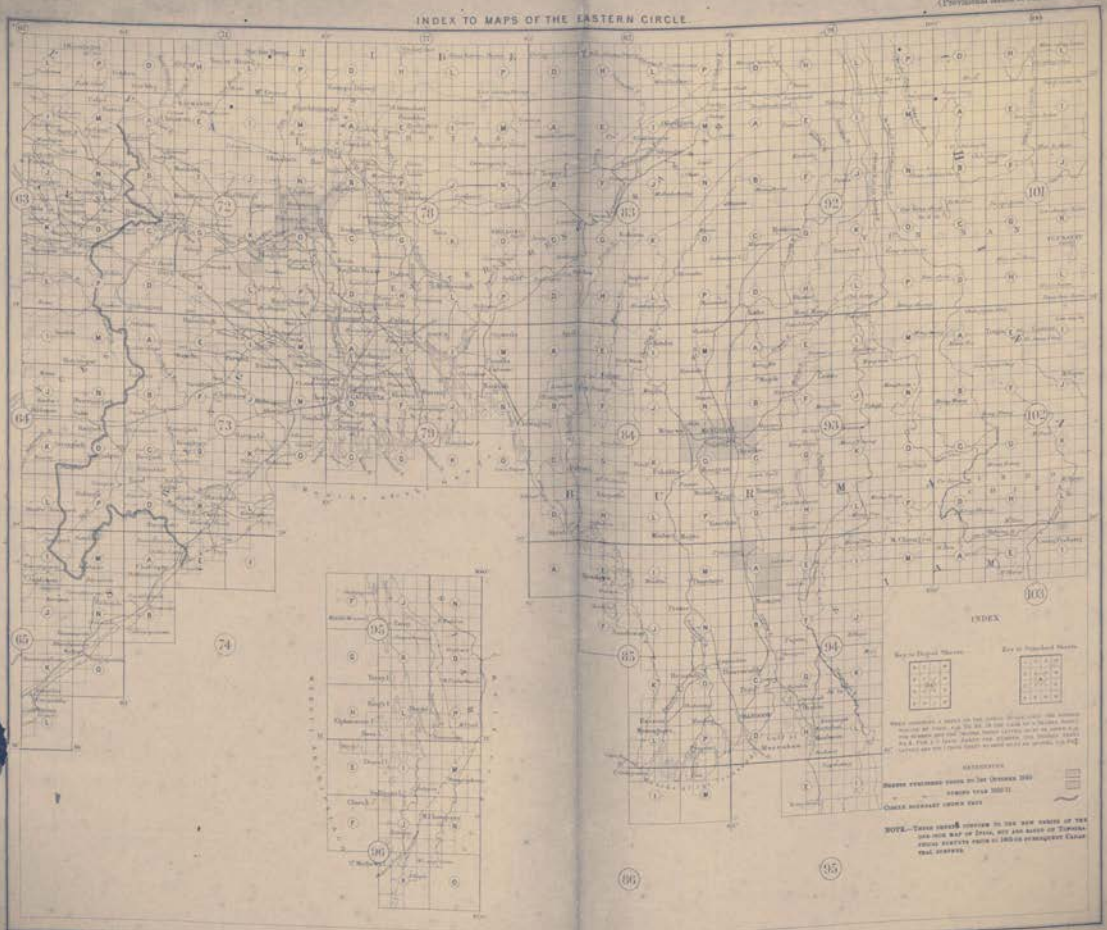
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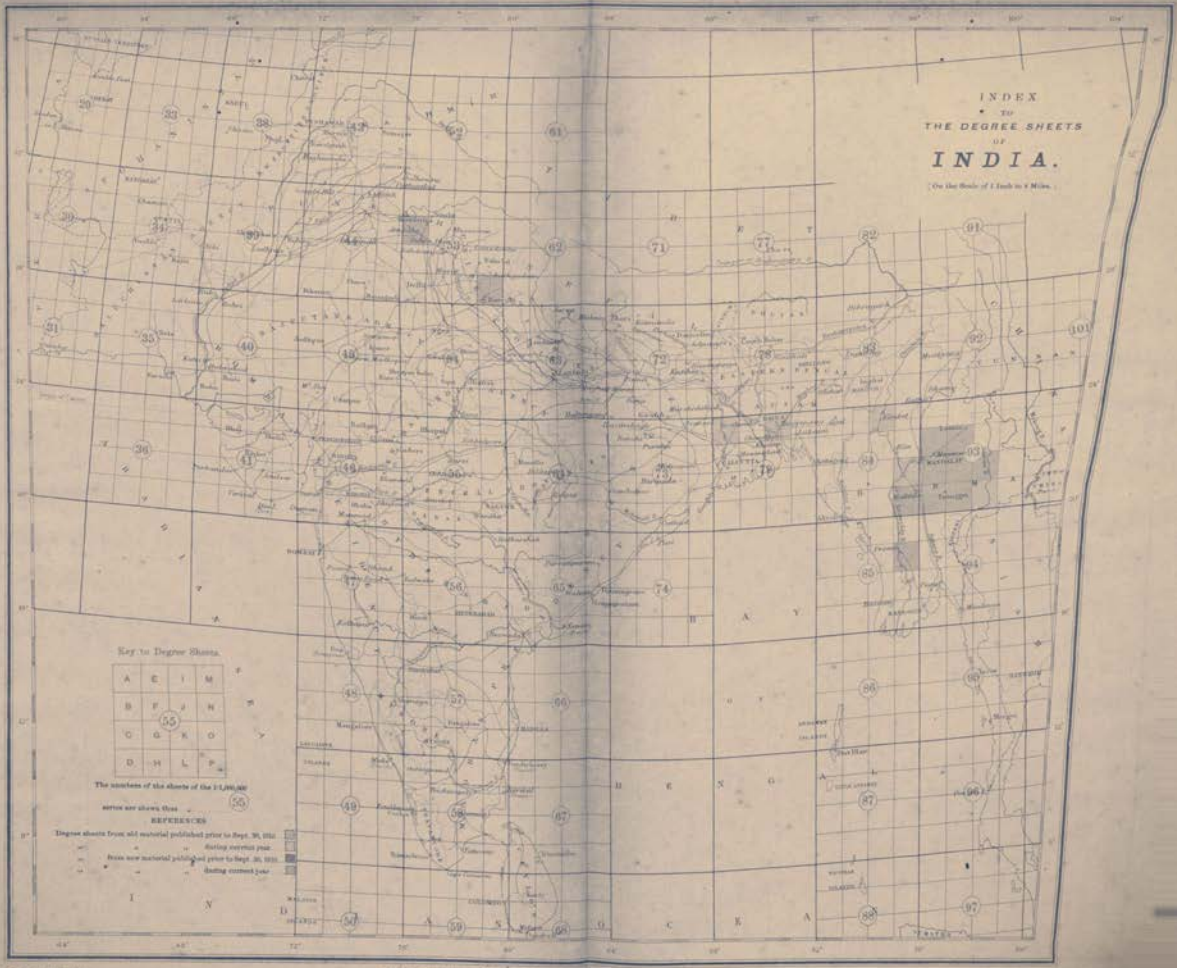

Published under the direction of Colonel S. G. Burrard, R.E., F.R.S., Surveyor General of India.

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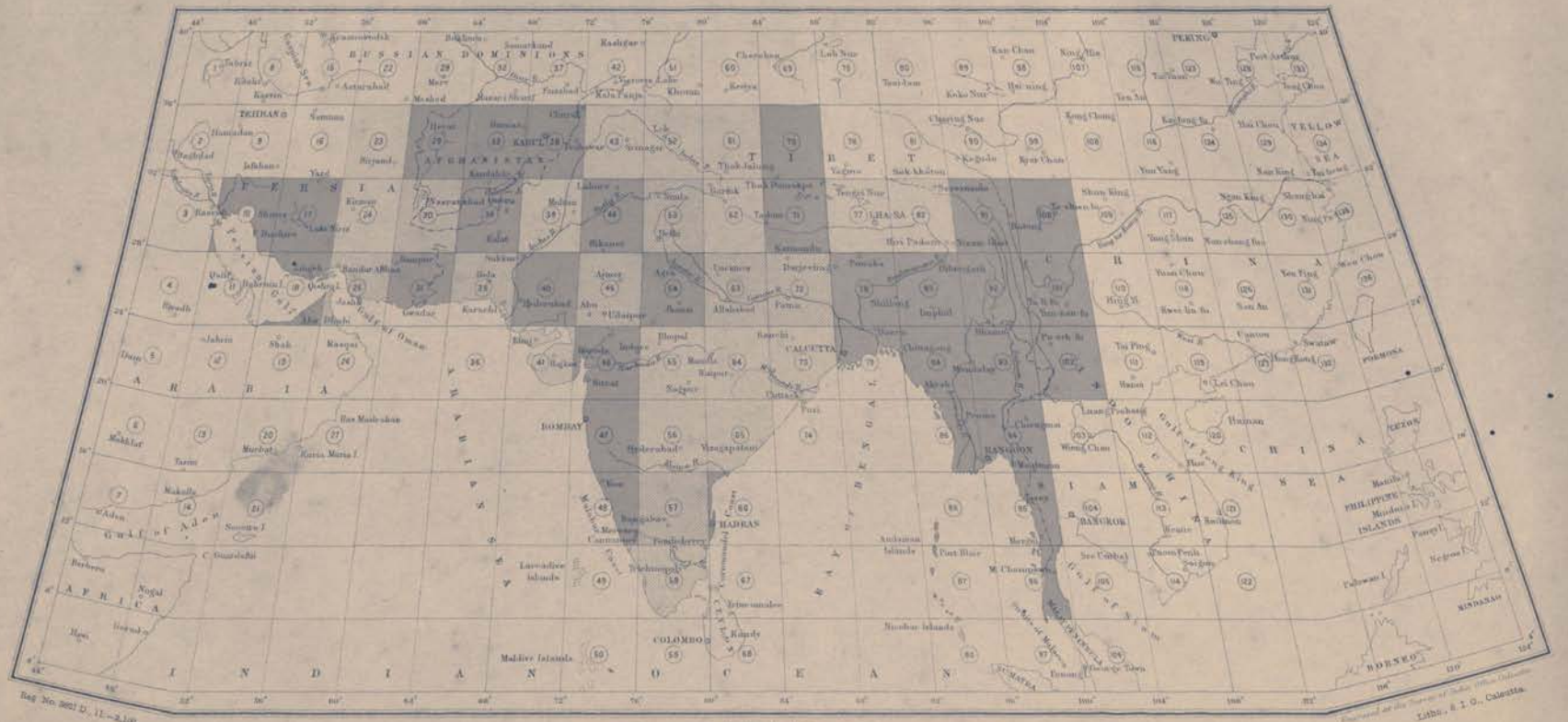
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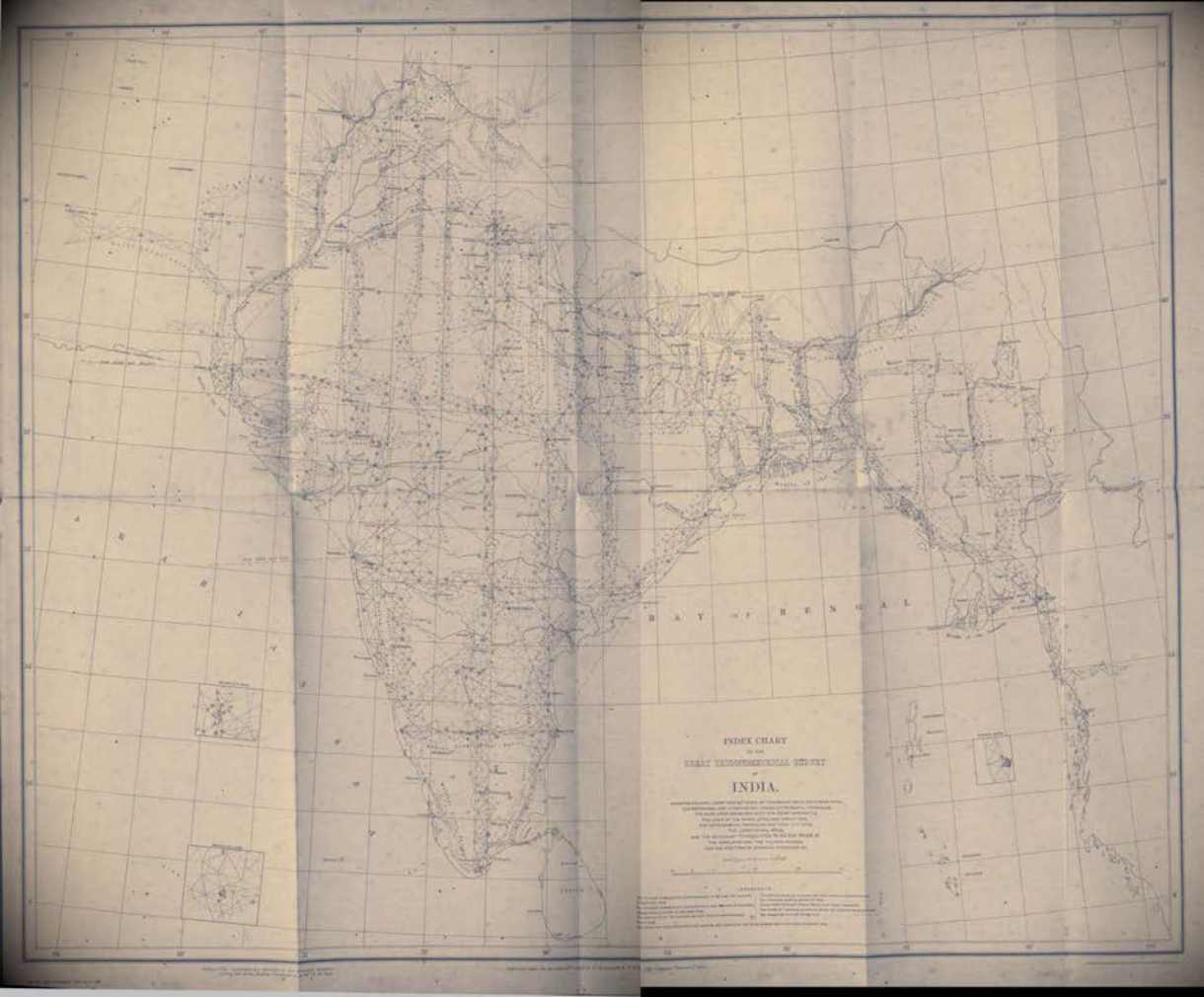
BAY OF BENGAL
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TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA.

PRESENTED
BY
BY
BY

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

DURING THE SURVEY YEAR

1912-13.

PREPARED UNDER THE DIRECTION OF

COLONEL S. G. BURRARD, C.S.I., R.E., F.R.S.,

SURVEYOR GENERAL OF INDIA.

ROYAL ASIATIC SOCIETY

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1912-13.

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PREFACE.

This report is intended to be general and concise. More detailed descriptions and discussions of results will be found in Volumes IV and V of the "Records of the Survey of India, 1911-12-13 and 1912-13, respectively."

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GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1912-1913.

PART I.

ADMINISTRATION.

1. This report deals with the operations of the Survey of India for the survey year commencing the 1st October 1912 and ending the 30th September 1913.

2. Colonel S. G. Burrard, C.S.I., R.E., F.R.S., the Surveyor General, administered the department until the 16th April when he went on leave and Colonel T. F. B. Renny-Tailyour, C.S.I., R.E., officiated as Surveyor General for the remainder of the year.

3. Lieutenant-Colonel P. J. Gordon, I.A., retired on the 23rd of September, and Lieutenant C. F. Nation, R.E., reverted to Military Duty with effect from the 2nd November. Three new Imperial Officers were appointed, namely, Lieutenants R. L. Almond, R.E., H. E. Roome, R.E., and H. M. McKay, R.E.

No Provincial officers were recruited.

4. During the year the Provincial Service reorganisation scheme was sanctioned, introducing, besides other benefits, an incremental time scale of pay combined with charge allowances and the granting of executive charges to Provincial officers.

Two new parties were created from the 1st March, *viz.*, No. 19 (Base Line) and No. 20 (Cantonment), and the six drawing offices were numbered and all are now executive charges. The drawing offices are now No. 1 (Calcutta), No. 2 (Dehra Dūn), No. 3 (Mussoorie), No. 4 (Bangalore), No. 5 (Shillong), No. 6 (Simla).

Two of the three posts of Survey Instructor were abolished.

5. The cost of the department for the financial year ending the 31st March 1913 was Rs. 33,74,174 against an estimated cost of Rs. 37,29,520.

6. The distribution of the officers in the various offices and parties is shown in the accompanying list.

DISPOSITION OF OFFICERS,

1912-13.

Circle or Branch.	Administrative Officer.	Party or Office.	Locality.	Imperial Officers.	Provincial Officers.	Upper Subordinates.	Lower Subordinate Establishment.	REMARKS.
MAP PUBLICATION.	Colonel S. G. Burrard, C.S.I., R.E., F. R. S., *Surveyor General*, up to 16th April 1913, Colonel T. F. B. Renny-Tailyour, C.S.I., R.E., *Offg. Surveyor General*, from 17th April 1913.	.....	Calcutta ...	.....	.....	.....	.....	
		Surveyor General's Office and Mathematical Instrument Office.	Calcutta ...	Lieutenant J. A. Field, R.E.	.....	.....	.....	
		No. 6 Drawing Office (Simla).	Simla ...	Major H. L. Crosthwait, R.E., Captain M. N. MacLeod, R.E.	Messrs. A. A. Graham, F. C. Saint, W. H. Strong.	.....	6 European draftsmen, 25 Indian draftsmen, 4 printers.	
	Major W. M. Coldstream, R.E., *Superintendent, Map Publication* up to 3rd July 1913, Major M. O'C. Tandy, R.E., *Offg. Superintendent, Map Publication* from 4th July 1913.	Map Publication Office.	Calcutta ...	.....	Mr. M. Gastaud.	.....	....	
		No. 1 Drawing Office.	Calcutta ...	Major M. O'C. Tandy, R.E., Captain C. M. Thompson, I.A., Captain F. F. Hunter, I.A.	Messrs. J. O. Greiff, C. Litchfield, Jagdamba Prasad, C. C. Byrne, P. L. Causley, A. B. Hunter, J. R. Newland, P. Simpson, P. N. Sur, E. J. H. Hanby, Abdul Hai.	.....	.....	
		Map Record & Issue Office.						
		Engraving Office.						
		Photo.-Litho. Office.	Calcutta ...	Captain C. M. Thompson, I.A., Captain S. W. S. Hamilton, R.E.	.....	.....	.....	

NORTHERN.	Major C. H. D. Ryder, D.S.O., R.E., up to 16th April 1913, Major C. L. Robertson, C.M.G., R.E., from 17th April, *Superintendent, Northern Circle.*	No. 3 Drawing Office.	Mussoorie ...	....	Messrs. B. R. Hughes, J. A. Freeman, M. C. Petters, H. C. H. Cooper, B. M. Berrill.	Mr. Husain Buksh, K. S. (*Retired 31-7-13.*)	52 Clerks, Draftsmen, &c.
		No. 1 Party ...	Kashmīr ...	Major F. W. Pirrie, I.A., Major A. A. McHarg, R.E., Lieut. K. Mason, R.E.	Messrs. H. H. B. Hanby, E. B. West, D. K. Rennick, R. C. Hanson, W. J. B. Miller.	Messrs. Sher Jang, K. B., Natha Singh, R. S., Lal Singh, R. B., Paras Ram, Jamna Prasad.	32 Surveyors, &c.
		No. 2 Party ...	Punjab ...	Major E. A. Tandy, R.E., Lieut. A. A. Chase, R.E.	Messrs. F. B. Powell, J. A. Freeman, Kanak Singh, R. E. Saubolle, E. C. O'Sullivan, J. McCraken, H. T. Hughes, J. A. Calvert.	....	55 Surveyors, &c.
		No. 3 Party ...	Punjab and U. P.	Captain M. N. MacLeod, R.E., Lieut. A. A. Chase, R.E., Lieut. F. B. Scott, I.A., Lieut. R. S. Wahab, I.A.	Messrs. J. O. Greiff, W. J. Newland, E. J. Biggie, A. C. Bose. P. A. T. Kenny, A. J. A. Drake, F. H. Grant, F. J. Grice, Moqimuddin.	Messrs. Mahomed Lutf Ali, Mahindar Singh	61 Surveyors, &c.
		No. 4 Party ...	United Provinces	Captain L. C. Thuillier, I.A.	Messrs. H. W. Biggie, G. J. S. Rae, C. E. C. French, J. C. C. Lears, G. E. R. Cooper, Duni Chand Puri.	Mr. Mohammad Husain Khan.	58 Surveyors, &c.
		No. 20 Party ...	Central Provinces	.....	Messrs. A. Ewing and C. E. C. French	Mr. Dharmu ...	12 Surveyors, &c.
		Riverain Detachment.	Punjab ...	.....	Messrs. Maya Das Puri, R. S., Moqimuddin.	Mr. Chuni Lal Kapur.	77 Surveyors, Traversers, &c., 155 Tahsildars, Kānungos, Patwāris, &c.

Circle or Branch.	Administrative Officer.	Party or Office.	Locality.	Imperial Officers.	Provincial Officers.	Upper Subordinates.	Lower Subordinate Establishment.	Remarks.
SOUTHERN.	Colonel T. F. B. Renny-Tailyour, C.S.I., R.E., up to 15th April 1913, Lieutenant-Colonel F. W. Pirrie, I.A., from 16th April 1913, *Superintendent, Southern Circle.*	No. 4 Drawing Office.	Bangalore ...	.....	Messrs. A. Ewing, J. H. Nichol, Balaji Dhondiba Maidbre.	Mr. B. V. Narayana Rao.	34 Draftsmen, &c., and 16 pupils.	
		Training Section.	Bangalore ...	.....	Messrs. W. M. Gorman, P. Kennegy ...	Messrs. P. S. Vengusvami, G. Hanumanta Rao.	1 Surveyor & 14 pupils.	
		No. 5 Party ...	Central Provinces.	Captain E. C. Baker, R.E., Captain K. W. Pye, R.E., Lieut. R. S. Wahab, I.A.	Messrs. F. P. Walsh, J. H. S. Wilson, S. S. McA'Fee Fielding, C. West, F. C. Pilcher, Munshi Lal, C. O. Picard.	Messrs. Eknath Battu, Ram Narayan Hastir.	29 Surveyors, &c., 4 pupils.	
		No. 6 Party ...	Berār and Hyderābād.	Major H. Wood, R.E., Lieut. C. G. Lewis, R.E.	Messrs. E. A. Meyer, F. B. Kitchen, R. B. Gildea, J. O'C. Fitzpatrick, A. J. Moore, A. V. Dickson.	Messrs. Lachman Daji Jadu, R. B., Dharmu.	36 Surveyors, &c., 3 pupils.	
		No. 7 Party ...	Madras, and Mysore.	Captain J. D. Campbell, R.E.	Messrs. J. O'B. Donaghey, P. R. Anderson, H. D. W. Stotesbury, Haji Abdul Rahim, K. B., H. H. P. Butterfield, J. C. St. C. Pollett.	Mr. K. Mandanna	28 Surveyors, &c., 1 pupil.	
		No. 8 Party ...	Madras and Travancore.	Captain C. M. Browne, D.S.O., R.E., Captain R. Foster, I.A.	Messrs. W. F. E. Adams, S. F. Norman, J. H. Williams, M. Mahadeva Mudaliar, Balaji Dhondiba Mandhre, M. S. Ganesa Aiyar.	Messrs Anantarao Dhondiba Mandhre, R. S., K. Narayanaswami Chetti.	32 Surveyors, &c., 4 pupils.	
EASTERN.	Bt.-Col. G. B. Hodgson, I.A., till April 27th, Lieut.-Colonel C. H. D. Ryder, D.S.O., R.E., from April 28th, *Superintendent, Eastern Circle.*	No. 5 Drawing Office.	Shillong, Assam.	Major C. P. Gunter, R.E., Captain O. H. B. Trenchard, R.E., Captain G. P. T. Oakes, R.E., Lieut. P. G. Huddleston, R.E.	Messrs. P. J. Barrington & E. Claudius	Mr. Abdul Hakk, K. S.	41 Surveyors, draftsmen, &c.	
		No. 9 Party ...	Bihār & Orissa.	Capt. R. H. Phillimore, R.E.	Messrs. Dhani Ram Verma, E. Claudius, B. C. Newland, A. K. Mitra, W. P. Hales, F. Byrne, D. N. Banerjee.	Messrs. Dalbir Rai, M. R. Mazumdar.	31 Surveyors, &c., 2 pupils, 5 Soldier Surveyors.	
		No. 10 Party ...	Upper Burma ...	Major E. T. Rich, R.E., Captain E. B. Cardew, R.E., Lieut. W. E. Perry, R.E.	Messrs. J. Smith, P. Williams, W. G. Jarbo, H. B. Simons, V. W. Morton, Asmat-Ullah Khan, K. S., C. B. Sexton, A. F. Murphy.	Mr. Hayat Muhammad, K. S.	29 Surveyors, &c., 5 pupils.	
		No. 11 Party ...	Lower Burma ...	Captain L. G. Crosthwait, I.A., Lieut. H. E. Roome, R.E.	Messrs. J. Smith, C. Litchfield, C. S. Littlewood, A. M. Talati, T. P. Dewar, H. St. J. Kenny, A. J. Booth, R. M. Wyatt.	Mr. Raghubar Datt Thaplyal.	31 Surveyors, &c.	
		No. 12 Party ...	Assam ...	Major A. Mears, I.A., Captain G. F. T. Oakes, R.E.	Messrs. W. Skilling, Pramadaranjan Ray, R. S., E. M. Kenny, Amjad Ali, L. Williams, P. C. Mitra, H. H. Creed.	Messrs. Nanak Chand Puri, Sajoni Kumar Ghosal.	33 Surveyors, &c., 4 pupils, 4 Soldier Surveyors.	

Lieut.-Colonel G. P. Lenox-Conyngham, R.E., *Superintendent of the Trigonometrical Survey.*	Trigonometrical Survey Office.	Dehra Dūn ...	Mr. J. de Graff Hunter, M.A., Lieut. K. Mason, R.E., Lieut. R. L. Almond, R.E., Lieut. H. M. McKay, R.E.	Messrs. Syed Aulād Hossein, K. B., H. A. Charrier, Hanuman Prasād.	Messrs. Sarat Kumar Mukerji, Ram Singh, R. S., Satish Chandra Mukharji, Lakshmi Dutt Joshi, and Govind Ram Kala.	.....
	No. 2 Drawing Office.	Dehra Dūn ...	Lieut. F. J. M. King, R.E. ...	Messrs. O. C. Ollenbach, E. C. J. Bond, H. C. W. Stotesbury.	Mr. Ram Singh, R. S.	.....
	No. 13 Party ...	Dehra Dūn ...	Major H. L. Crosthwait, R.E., Capt. V. R. Cotter, I.A.	.. ...	Mr. Bidhu Bhusan Shome.	1 Computer.
	No. 14 Party ...	U. P., Rājputāna, & C. I.	Capt. H. J. Cotchman, R.E.	Messrs. Hanuman Prasād, O. N. Pushong.	.....	4 Computers.
	No. 15 Party ...	Madras, Kashmir, Bombay, Bengal, & C. P.	Major H. McC. Cowie, R.E., Lieut. K. Mason, R.E.	Messrs. C. H. Tresham, V. D. B. Collins, V. P. Wainright, G. A. Norman, B. T. Wyatt, C. S. McInnes, Abdul Karim, N. S. Harihara Iyer.	Mr. Jugal Behari Lal.	24 Computers, &c.
	No. 16 Party ...	Indian Ports ...	.....	Messrs. H. G. Shaw, Syed Aulad Hossein, K. B., Syed Zille Hasnain.	.....	20 Computers, &c.
	No. 17 Party ...	Burma and Punjab.	Captain V. R. Cotter, I.A., Lieut. A. A. Chase, R.E.	Messrs. H. G. Shaw, O. N. Pushong, D. H. Luxa, T. F. Kitchen, F. W. Smith, O. D. Jackson, Jiya Lal, N. N. Chuckerbutty.	Messrs. Ram Singh, R. S., K. K. Das.	14 Computers, &c.
	No. 18 Party ...	India & Burma.	Capt. R. H. Thomas, R.E.	Messrs. H. P. D. Morton, Rama Prasād Ray, N. R. Mazumdar, Raj Bahadur Mathur.	Mr. Bidhu Bhusan Shome.	19 Recorders, &c.
	No. 19 Party	India & Burma	Major H. McC. Cowie, R.E., Major E. A. Tandy, R.E., Lieut. A. A. Chase, R.E.	.....	... ..	.....
	Forest Map Office.	Dehra Dūn ...	Lieut. F. J. M. King, R.E. ...	Messrs. J. H. Nichol, O. C. Ollenbach.	...	.....

PART II.

SURVEY WORK IN THE FIELD.

I.—TOPOGRAPHICAL SURVEYS.

NORTHERN CIRCLE (*vide* index map No. 1).

7. *No. 1 Party.*—This Party continued its field operations in the Kashmīr and Jammu State throughout the year. An area of 3,091 square miles in the Pūnch State, the Mīrpur, Riāsi, and Jammu districts was surveyed on the 1-inch scale, the country varying from the low flat plains bordering on the Gujrāt district of the Punjab, to the high ranges of the Pīr Panjāl. In addition, areas of 684 and 1,036 square miles on the $\frac{1}{2}$-inch and $\frac{1}{4}$-inch scales were revised in the open mountainous tracts of the Gilgit and Ladākh districts respectively, bordering on those areas surveyed last year. The head-quarters of the Party were retransferred from Srīnagar (Kashmīr) to Mussoorie in April 1913.

8. *No. 2 Party.*—No. 2 Party surveyed 36 1-inch sheets giving an area of 9,245 square miles. Most of this was revision of existing 1-inch maps in Lahore, Ferozepore, Ludhiāna, Hissār and neighbouring districts, and in Farīdkot and Māler Kotla States; also new survey in the western portions of the Phūlkiān States; all plains. There was 1 sheet of revision survey in the Siwāliks, on the border of Hoshiārpur district, which was partly hills and partly plains, and revised on a variety of existing scales. Except for this the country was plain and fairly open, with slight undulations and sandy outcrops in the southern parts. No contouring or height work was attempted in the plains, a fair number of heights indicating the general line of the country being subsequently abstracted from the maps of the Irrigation Department. Ferozepore cantonment and a few important towns were surveyed on a slightly larger scale in order to secure full detail for the 1-inch maps.

A small six-inch survey of Māler Kotla and environs was paid for by Māler Kotla State. A man was sent to the Dera Ghāzi Khān neighbourhood to sketch in the great alterations due to the movements of the Indus, for incorporation in the new degree sheet of that area.

9. *No. 3 Party.*—This Party was originally intended for work in the United Provinces in continuation of last year's programme, but was moved into the Punjab for special surveys, required by the Irrigation Department. It surveyed a total area of 7,724 square miles, of which 4,960 square miles was 1-inch revision survey, and 2,764 square miles 1-inch survey. The former comprised parts of the districts of Ambāla and Karnāl, and the latter the eastern portions of the Phūlkiān States, of Patiāla, Nābha, and Jīnd. To supply data for the new survey, a traverse section of this Party ran traverses over an area of 6,058 square miles in the Phūlkiān States. With the exception of the foot hills of the Punjab, Siwāliks in the North, the country was flat alluvium, much irrigated and generally wooded. The old 1-inch maps utilised for the revision survey, except for the village sites, were not of much assistance. The new maps show a large amount of detail.

10. *No. 4 Party.*—This Party surveyed an area of 5,460 square miles in the districts of Bahraich, Gondā, Lucknow, Bāra Bankī, Rāe Barelī, Fatehpur, Fyzābād, Sultānpur, Partābgarh and Hardoī. The country surveyed consisted chiefly of flat plains, well cultivated and covered with an abundance of artificial groves. The rivers Ganges, Gogrā, Gumtī and Rāptī ran through portions of the work.

The Cantonment Section was transferred to No. 20 Party from 1st August and the work of this section is reported under Section IV (Cantonment Surveys).

11. *The Punjab Riverain Detachment.*—This detachment continued the work of traversing and laying down base lines. 319 linear and 394 square miles of main traverse, and 3,256 linear and 808 square miles of minor traverse were run. 13,833 theodolite stations were fixed in the area, under water action of the rivers Sutlej, Rāvi, Chenāb, and Jhelum in districts Ferozepore, Lahore, Siālkot, Gujrāt, and Shāhpur, and 588 corners of 196 squares were demarcated with permanent mark-stones on both banks of the Sutlej (districts Montgomery and Ferozepore), Chenāb (districts Gujrāt and Siālkot), and the Jhelum (districts Shāhpur and Jhelum) to serve as bases for the future demarcation of boundaries in the bed of these rivers. 3,496 plotted and 697 boundary "*masāvis*" (settlement mapping sheets) of 407 villages were completed and 49 4-inch sheets were traced, and supplied in time to the Settlement Officers of Ferozepore, Lahore, Siālkot, Gujrāt, and Shāhpur. Besides these, 363 miscellaneous traces were prepared, and all the traverse stations marked during the season were plotted on 51 4-inch sheets. Three 4-inch riverain boundary sheets were plotted and compiled, 2 sheets finally completed, and 4 sheets typed.

12. The 25 acre rectangular survey was carried over the remaining tract commanded by the Lower Bāri Doāb Canal in continuation of the last year's work. Fourteen thousand, six hundred and twenty seven 25 acre rectangles were broken. Nearly 56 per cent. of the work was tested by the tahsildārs, naib tahsildārs, and the survey officers, and 16 per cent. was checked with theodolite traverse. 1,059 linear miles were traversed, and 3,895 theodolite stations were fixed. This work is now completely finished.

13. The Khushāb *Thal* (sandy area) survey was suddenly taken up during February 1913 at the special request of the Punjab Government. 1,967 linear and 1,070 square miles were traversed, and 3,808 theodolite stations laid out. 258 dressed stones and 84 iron tubes were embedded on certain selected stations to facilitate future survey and demarcation of fields and boundaries. 591 plotted *masāvis* on the scale of 12 inches to one mile were supplied to the Settlement Officer, Shāhpur, early in September 1913.

In addition to the above, 604 *masāvis* of 36 villages (scale 8 inches to one mile) were reduced to the scale of 4 inches to one mile. The boundaries of these villages were compiled on 29 4-inch sheets showing discrepancies of over two chains, and their traces prepared on 63 *masāvis* for the Settlement Officer, Shāhpur.

14. With a view to assist the Settlement Officer, Dera Hamīrpur and to utilize the experience thus gained for the cadastral surveys of tahsils Pālampur, Kāngra and Nūrpur, the Kāngra work was experimentally started during the middle of April 1913. 637 linear and 81 square miles were triangulated and traversed and 1,840 stations fixed with theodolite. 784 plotted *masāvis* of 256 *tikās* (sub-villages) were supplied to the Settlement Officer, Dera Hamīrpur. The experiment has proved successful, and work will be commenced in the three tahsils during next field season.

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SOUTHERN CIRCLE (*vide* index map No. 2).

15. *No. 5 Party.*—No. 5 Party surveyed an area of 3,690 square miles in the Hoshangābād, Narsinghpur, Betūl, Chhindwāra, Nāgpur, Bhandāra, Seonī and Bālāghāt districts of the Central Provinces and triangulated an area of 4,972 square miles in Hoshangābād, Narsinghpur, Betūl, Chhindwāra, Seonī, Bhandāra, Bālāghāt, Nāgpur and Wardhā districts of the Central Provinces and in the Amraotī district of Berār. The nature of the country surveyed varied from the steep and wooded hills on the north of the Sātpurā plateau to the flat and undulating cultivated lands in the Nāgpur plain.

16. *No. 6 Party.*—No. 6 Party surveyed an area of 3,028 square miles in the Yeotmāl, Akola and Buldāna districts of Berār and in the Adilābād, Nānder and Parbhani districts of Hyderābād and triangulated an area of 2,795 square miles in the East Khāndesh districts of Bombay, in the Buldāna and Akola districts of Berār and in the Parbhani and Nānder districts of Hyderābād. The country was of an intricate nature similar to that surveyed in previous years. The ½-inch survey of Hyderābād State was commenced and the increased out-turn of the party is due to the rapidity of survey on this scale.

17. *No. 7 Party.*—No. 7 Party surveyed an area of 5,017 square miles in the Malabar, South Kanara, Salem, Coimbatore and North Arcot districts of Madras, and in the Bangalore, Kolār and Mysore districts of Mysore, and triangulated 4,642 square miles in the Salem, Chittoor and North and South Arcot districts of Madras. The country surveyed was very varied in character. It includes the flat intricate coast, the undulating jungle-clad foot-hills of the Western Ghāts, the densely wooded, hilly country on both banks of the Cauvery river and the open undulating Mysore plateau.

18. *No. 8 Party.*—No. 8 Party surveyed an area of 1,614 square miles and traversed 205 linear miles in the Malabar and Madura districts of Madras and in Travancore State. Along the sea coast the country is covered with dense cocoanut groves and paddy cultivation which is flooded for the greater part of the year. On leaving the sea coast the country gradually changes in character and is at first undulating and densely populated and cultivated with scrub or tree jungle on the low hills. Further inland the cultivation and inhabitants are less and the forest areas become more numerous and denser with open grassy tops to the high hills. The work in such country was of necessity slow, difficult and expensive.

EASTERN CIRCLE (*vide* index map No. 3).

19. *No. 9 Party.*—No 9 Party surveyed an area of 4,030 square miles in Singhbhūm and Rānchī districts and in the Feudatory States of Orissa. Of this area 1,189 square miles in the Feudatory States were surveyed on the ½-inch scale, and 30 square miles of reserved forest in Singhbhūm district were surveyed on the 2-inch scale; the remaining area was surveyed on the 1-inch scale. The country surveyed was mostly wooded and hilly, but on the Rānchī plateau, undulating and well cultivated. 253 linear miles of forest boundaries were traversed by theodolite within Singhbhūm district. Triangulation was carried out in districts Hazāribāgh, Monghyr, Bhāgalpur and Santāl Parganas.

20. *No. 10 Party.*—No. 10 Party surveyed an area of 2,496 square miles, in the Myitkyinā district of Upper Burma, including 24 square miles of country beyond the Burma-China frontier and in unadministered territory which were sketched; 2,700 square miles were triangulated and traversed in the Myitkyinā district and 207 linear miles of forest boundary traverse were completed. The country surveyed varied from the level plains round Myitkyinā and Talawgyi on both sides of the Irrawaddy which were less than 500 feet above sea level, to the high hills along the Burma-China Border some of which were over 12,000 feet high and covered with snow during the winter months. Both plains and hills were thickly wooded and it was difficult to get any views of the surrounding country except where ground had been cleared for cultivation.

In April a drawing office was opened in Maymyo for the preparation of degree sheets of Burma and of special maps dealing with the Burma frontier such as those surveyed with Political Missions, &c.

One Upper Subordinate and three surveyors were attached to Political Missions during the field season.

21. *No. 11 Party.*—No. 11 Party surveyed an area of 1,960 square miles in the Tavoy district of the Tenasserim division of Lower Burma and triangulated an area of 3,929 square miles in the same district and in the north of the Mergui district. The country surveyed varying from mangrove swamps to hills rising to 6,800 feet lay between the sea coast and the Siamese frontier, the greater part of it being thinly populated or entirely uninhabited. The work also included the North and Middle Moscos Islands, which lie from fifteen to twenty miles off the coast. Owing to a hot and damp climate with an average annual rainfall of 230 inches the evergreen jungle is very dense and often impenetrable; this, together with scarcity of labour, supplies, local transport and communications made survey work slow and difficult.

Six Superintendents of the Burma Land Records Department were attached to the party for training in plane-tabling for two months each.

One surveyor was attached to the North Burma Exploration Survey Detachment and another was employed on reconnaissance work under an officer of the Intelligence Branch of the Army Department.

22. *No. 12 Party.*—No. 12 Party surveyed an area of 3,374 square miles in the Kāmrūp, Darrang and Nowgong districts of Assam and carried out triangulation and traversing over an area of 4,500 square miles. The above area includes 43 square miles of reserved forest surveyed on the 2-inch scale. The country under survey consisted principally of the alluvial plains of the Brahmaputra which, where not under cultivation, are covered with high grass and scattered tree jungle interspersed with immense swamps and "bils"; the balance of the area consisted of hills for the most part densely wooded.

TOPOGRAPHICAL SURVEYS.

Table showing Out-turns and Costs.

1912-1913.

1	2	3	4	5	6	7	8	9	10	11	12
Circle.	Party.	Locality.	Character of Ground.	Type of Survey.	Scale.	Out-turn. Survey.	Total Out-turn of Survey on all scales.	Difference from 6,000 square miles per party. (*a*)	Total cost.	Cost-rate per square mile. Survey and Mapping.	REMARKS.
						Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Rs.*	*Rs.*	
N.	No. 1	Kashmīr State ...	Mostly hilly and wooded ...	Survey ...	1-inch	3,091	4,811	—1,189	1,12,659	23·4	
				Revision Survey	½-inch	684					
				Revision Survey	¼-inch	1,036					
N.	No. 2	Punjab ...	Partly plains, partly Siwalik hills.	Revision Survey	1-inch	6,331	9,245	+3,245	1,11,252	12·0	
				Survey ...	1-inch	2,661					
			Plains fairly open, no heights or contours.	Revision Survey	2, 3 & 4-inch.	253					
N.	No. 3	Punjab and U. P. ...	Flat Alluvium ...	Survey ...	1-inch	2,764	7,724	+1,724	1,42,734	18·5	
				Revision Survey	1-inch	4,960					
N.	No. 4	United Provinces ...	Plains wooded and open ...	Resurvey and supplementary survey.	1-inch	5,460	5,460	—540	96,477(*b*)	17·7	(*b*) Excluding cost of Cantonment Section, Rs. 18,620 (*vide* table on p. 18).
			Totals, Northern Circle ...	.....	...		27,240	+3,240	4,63,122	17·00	

(*a*) The figure 6,000 (square miles) from which differences are shown in column 9 is the full out-turn per party which it is hoped to attain in the future.

TOPOGRAPHICAL SURVEYS.

Table showing Out-turns and Costs.—(Contd.)

1912-13.

1	2	3	4	5	6	7	8	9	10	11	12
Circle.	Party.	Locality.	Character of Ground.	Type of Survey.	Scale.	Out-turn. Survey.	Total Out-turn of Survey on all scales.	Difference from 6,000 square miles per party. (*a*)	Total cost.	Cost-rate per square mile. Survey and Mapping.	Remarks.
S.	No. 5	Central Provinces	Varied, wooded hills and cultivated plains.	Survey ..	4-inch	2,575	3,690	—2,310	1,13,888	30·9	
			Wooded hills ...	Revision Survey	1-inch	1,115					
S.	No. 6	Berār & Hyderābād ...	Varied, open plains undulating plateau intricate forest-clad hills.	Survey ...	½-inch	4,086	3,028	—2,972	99,631	32·9	
			Open undulating plains with deep ravines.	Survey ...	1-inch	1,508					
			Intricate ground with thin forest.	Survey ...	2-inch	434					
S.	No. 7	Madras & Mysore ...	High forest-clad hills and undulating open plateau.	Survey ...	1-inch	652	5,017	—983	87,694	17·5	
				Revision Survey	1-inch	4,040					
			Flat coast, low jungle clad foot-hills.	Survey ..	1½-inch	312					
				Survey ...	2-inch	13					
S.	No. 8	Madras & Travancore	Flat enclosed coast country	Survey ...	1½-inch	256	1,614	—4,386	1,32,777	82·3	Very difficult country.
			Open hills, forest and flat enclosed.	Survey ...	1-inch	1,358					
			Totals, Southern Circle ...	.....	.....	....	13,349	—10,651	4,33,990	32·51	

E.	No. 9	Bihār & Orissa ...	Wooded hills and undulating plateau.	Supplementary Survey.	1-inch	2,303	4,030	—1,970	1,03,135	25·5	
			Thickly wooded hills ...	Revision Survey	1-inch	476					
			Open undulating ground...	Survey ...	1-inch	32					
			Wooded undulating ground with hills.	Revision Survey	½-inch	1,189					
			Thickly wooded hills ..	Survey ...	2-inch	30					
E.	No. 10	Upper Burma	Mostly hilly and thickly wooded.	Survey ...	1-inch	2,347	2,472(*c*)	—3,528	1,33,466(*d*)	53·9	(*b*) Trans-border reconnaissance. (*c*) Excluding reconnaissance survey. (*d*) Excludes Rs. 36,238 expended on exploration surveys, forest boundary surveys and Maymyo Drawing Office. Cost-rate is high owing to difficult nature of ground and expense of transport.
				Reconnaissance Survey.	1-inch	24(*b*)					
				Survey ...	2-inch	125					
E.	No. 11	Lower Burma	Densely wooded; partly undulating, partly steep hills	Survey ...	1-inch	1,745	1,960	—4,040	1,36,648(*e*)	69·7	(*e*) Excluding Rs. 14,449 on instruction and reconnaissance.
				Survey ...	2-inch	215					
E.	No. 12	Assam	Partly open plains and grass jungle, partly densely wooded hills.	Survey ...	1-inch	935	3,374	2,626	1,38,006(*f*)	40·9	(*f*) Excludes Rs. 2,154 for special forest survey but includes Rs. 2,865 expenditure on traversing forest boundaries. (*g*) Excludes 6 square miles of special forest survey.
				Revision Survey	1-inch	116					
				Supplementary Survey.	1-inch	2,286					
				Survey ...	2-inch	37(*g*)					
			Totals, Eastern Circle ...		..	.....	11,836	—12,164	5,11,245	43·19	
			GRAND TOTALS ...	...	...	.....	52,425	—19,575	14,08,357	26·86	

(*a*) The figure 6,909 (square miles from which differences are shown in column 9 is the full out-turn per party which it is hoped to attain in the future.

Table showing progress of Topographical Surveys, 1905 to 1913.

Survey year.	Scale.	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
		Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-06	1-inch and 2-inch	5,995	1,660	10,322	17,977
1906-07	do.	7,277	7,666	8,659	23,602
1907-08	do.	14,530	9,256	12,431	36,217
1908-09	do.	17,957	12,526	11,542	42,025
1909-10	do.	23,833	12,532	9,736	46,101
1910-11	do. and 1½-inch	27,528	13,171	9,218	49,917
1911-12	do.	23,852	9,115	(*a*)10,654	43,621
1912-13 ...	do. and ½-inch	27,240	13,349	11,836	52,425
Areas completed to date	.....	148,212	79,275	84,398	311,885
Total areas included in topographical programme.	Total of 1-inch & ½-inch work allotted.	750,000	542,800	528,800	1,821,600
Approximate areas remaining for Survey	Total of 1-inch & ½-inch work still remaining.	601,788	463,525	444,402	1,509,715

(*a*) The area reported in 1911-12, wrongly included 1,628 square miles surveyed by No. 11 Party on ½-inch scale.

NOTE 1.—As was suggested in the note on page 12 of the General Report of the Survey of India for 1910-11, the question of reducing the scale of survey in certain regions has now been considered, and the half-inch scale has been accepted for a larger area than was contemplated in the original topographical programme. The exact figures showing the areas allotted to 1-inch and ½-inch surveys, respectively, are not to hand as yet, and only the total figures for both scales can be shewn.

The reasons for this reduction of the scale of survey are as follows:—(1) to enable the completion of the survey programme to be carried out by 1935 if possible, (2) to reduce the expenses of survey in hilly, desert or other depopulated regions, where the one-inch scale for maps seems at present unnecessary.

NOTE 2.—The figures showing the total areas included in the topographical programme of the circles and the areas remaining for survey are liable to future correction, (1) because the limits of the several circles have not been everywhere settled, (2) because in some small areas surveys are not found up to standard and require revision. These areas get unavoidably included both in the totals for the year of actual survey and in the totals for the year in which the revisionary survey takes place, and the figures thus become slightly incorrect.

II.—GEOGRAPHICAL SURVEYS.

23. A large amount of exploration on the North East frontier was carried out during 1911-12 and 1912-13.

24. The detachment under Lieutenant Lewis, R.E., with the Miri Mission in 1911-12 surveyed 2,000 square miles in the basin of the Subansirī and its affluents the Khru and Kamla Rivers and fixed a large number of peaks on the main Himālayan range.

25. In the Abor country during 1911-12 and 1912-13 a detachment under Captain Trenchard, R.E., surveyed the whole valley of the Dihāng and its tributaries up to Latitude 29°30′ (except the headwaters of the Siom River); an area of 6,500 square miles. A large number of peaks on the main Himālayan range were also fixed, including one of over 25,500 feet.

26. The detachment under Major Gunter, R.E., with the Mishmi Mission explored the Luhit River up to the neighbourhood of Rimā in 1911-12 and surveyed the whole of the basin of the Dibāng River and its tributaries in 1912-13, completing an area of 8,848 square miles, and fixed a large number of peaks on the main Himālayan range.

27. The detachment under Captain Cardew, R.E., which accompanied the North Burma Missions of 1911-12 and 1912-13 surveyed an area of 10,000 square miles, nearly completing the exploration of the Irrawaddy basin. Surveyors also accompanied the late Captain Pritchard in both seasons, and including their work, a total area of well over 30,000 square miles of hitherto unexplored country has been surveyed on the $\frac{1}{4}$-inch scale.

III. FOREST SURVEYS.

28. During the year 1912-13, the forest surveys have, as usual, been carried out by the Topographical parties of the Survey of India. In the majority of cases, the surveys were executed on the scale of two inches to the mile but in some few instances, the work was done on the one-inch scale. A considerable extent of forest boundaries was also surveyed on the scale of 4 inches to the mile. The revision of certain areas previously surveyed on the 4-inch scale by the old Forest Survey Branch was also effected.

Northern Circle.

29. No forest surveys were carried out in this Circle during the year under report.

Southern Circle.

30. *Central Provinces. (Berār Circle).*—No. 6 Party continued the topographical survey of Berār and Hyderābād. All A and B class forests, and C class forests over one square mile in area falling in the area under survey and in six of the sheets to be surveyed in the next and following seasons were surveyed on the 2-inch scale.

With the approval of the Chief Conservator of Forests, no theodolite boundary traverses were carried out, but all the reserve boundaries were surveyed by plane-table traverse on the 4-inch scale; this ensured better agreement with the topographical details. The survey of all the forests in Yeotmāl district was completed and work was also done in Akola and Buldāna districts. The old 4-inch map of Gerumātergaon reserve in Buldāna was too inaccurate to be utilised and a new 2-inch survey was commenced. The area of forests surveyed on the 2-inch scale amounted to 375·6 square miles and the plane-table boundary surveys amounted to 984·8 linear miles.

31. *Madras Presidency.*—No. 7 Party in the course of its ordinary operations carried out the survey on the 2-inch scale of the Mambetta reserve and Doddasampagai extension of Kollegāl division amounting to 11·6 square miles. No new boundary traverses were carried out.

Eastern Circle.

32. *Bihār and Orissa.*—In the course of its regular operations, No. 9 Party surveyed an area of 30 square miles of protected forests, on the 2-inch scale and 32 square miles on the 1-inch scale, in the Singhbhūm and Chaibāsa divisions; and theodolite traverses amounting to 253 linear miles, were run round the boundaries of all the blocks over 1 square mile in area which have not been previously surveyed. The survey of all the forests in the Singhbhūm forests division and of such forests of the Chaibāsa division as fall in the Singhbhūm district, has now been completed.

33. *Upper Burma (Northern Circle).*—During the year under report, No. 10 Party surveyed the Maingna, Zigyun, Talawgyi and Kawan reserves in the Myitkyinā division, amounting to 116½ square miles, on the 2-inch scale and part of the Padaung game reserve, area 27 square miles, on the 1-inch scale. In addition to these, 207 linear miles of boundary survey was completed round the Maingna, Talawgyi, Kawan, Namkwin and part of Padaung reserves. The Conservator of Forests, Northern Circle, agreed to the survey of the Padaung reserve being done on the 1-inch scale instead of the 2-inch scale, as it is only reserved as a game sanctuary and not for timber preservation.

34. *South Tenasserim Division (Tenasserim Circle).*—Parts of the Heinzè and Kaleinaung reserves amounting to 212 square miles and the whole of Pandin-In reserve, area 3 square miles, were surveyed by No. 11 Party on the 2-inch scale and their boundaries, 59½ linear miles, were traversed by theodolite.

35. *Assam.*—No. 12 Party surveyed the Darranga, Khalingduar and its extension and Singri Hill reserves, on the 2-inch scale in course of its ordinary operations. In addition to this, the two small reserves of Hājo and Sildar Hill surveyed on the 1-inch scale last year, were at the special request of the Conservator of Forests, Western Circle, resurveyed on the 2-inch scale. The total area thus surveyed amounted to 37 square miles. An area of some 6 square miles was also surveyed on this scale in the Upper Dehing reserve (western block) and its boundary, 50 linear miles, traversed on the 4-inch scale. This being a special survey, its cost will be borne entirely by the Forest Department. Sonaikusi and Kolahat reserves, area 44 square miles, which were previously surveyed on the 4-inch scale by the old Forest Survey Branch, were revised on the 1-inch scale, as the contouring and heights were found unreliable. The artificial boundaries only of the following reserves, amounting to 167½ linear miles, have been traversed on the 4-inch scale, during the year under report:—Khalingduar Extension, Singri Hill, Jungthung, Chelabor, Sildharampur, Laokhawa and Kaziranga.

IV.—CANTONMENT SURVEYS.

36. *No. 20 Party (Cantonment).*—During the year this Party was formed to survey cantonments and towns on large scales, and also to train soldier surveyors who after a further training in this party, are to be transferred to the Military Works Department to revise and keep up to date all cantonment plans completed by the Survey of India Department.

37. From 1st August 1913, the Cantonment Section of No. 4 Party was converted into this new Party, and its strength was increased by recruiting pupil surveyors and by the transfer of a Provincial Officer and an Upper Subordinate from other parties.

38. During the year the cantonment section and the party completed the survey of Quetta Cantonment, Quetta Civil Station and Quetta Fort, which were then in hand, and also completed an extension of 8·25 square miles of the Delhi New Cantonment Area which was surveyed the year previous for the Town-planning Committee, and in addition surveyed Saugor Cantonment and its bazaars, and also triangulated Guna.

39. The mapping of Quetta Cantonment, Quetta Civil Station and Quetta Fort is in hand and will soon be sent for publication.

The programme for the ensuing year is the survey of Guna, Kamptee, and Rājkot cantonments and also other additional cantonments which may be required by the Director-General of Military Works.

Table showing out-turn and cost-rates of Cantonment Surveys, 1912-13.

Cantonments.	Class of Survey.	Scale.	Out-turn. Acres.	Total cost.	Cost-rate per acre, Survey and mapping.	Remarks.
				Rs.	*Rs.*	
Delhi ...	Survey ...	4″=1 Mile	5,280		0·50	
Quetta and Saugor ...	Re-survey	16″=1 Mile	6,464	22,144*	2·75	*Includes Rs. 18,620 cost of Cantonment Section of No. 4 Party prior to the formation of No. 20 Party.
Saugor ...	,,	64″=1 Mile	95		6·37	
			11,539			

V.—TRIGONOMETRICAL SURVEYS.

GEODETIC SURVEY.

(a).—Astronomical Latitudes.

40. *No. 13 Party.*—As no Officer was available, no Astronomical Latitudes were observed during the field season 1912-13.

(b).—Pendulum Operations.

41. *No. 14 Party.*—No. 14 Party made pendulum observations at 14 stations along a line stretching from Bhopāl to Bulandshahr, thus filling in the gap between Major Lenox-Conyngham's work from Mussoorie to Meerut and Captain Cowie's observations in the Central Provinces. The table annexed gives the results of the observations. These results are not comparable with those of previous years, as we have now begun to use a new formulæ for computing γ_0 The results at all stations are, however, being published in a new Professional Paper.

The stations Bhopāl to Guna form part of the "hidden chain" or belt of high density and the existence of two other small belts is indicated by the Hayford residuals.

42. The results of the investigation into the theory of isostatic compensation appear to show that the Himālaya are not completely compensated and further that the partial compensation beneath them extends beyond their foot into the plain. This investigation is not yet complete.

43. Comparative observations between the Indian pendulums and those of the De Filippi expedition have lately been made at Dehra Dūn. The results, when available, will give an independent determination of the value of gravity at this, our base station.

For Summary of results, see page 20.

PENDULUM OPERATIONS.

Summary of Results.

1912-13.

Stations.	Latitude. ϕ	Longitude.	Height.	Computed value of gravity at sea level. γ_0*	Corrections for			γ_0 corrected for height. γ_A	γ_0 corrected for height and Mass (Bouguer). γ_B	γ_0 corrected for height and Mass (Hayford). γ_C	Observed value of gravity. g.	$g-\gamma_A$	$g-\gamma_B$	$g-\gamma_C$
					Height.	Mass (Bouguer).	Mass (Hayford).							
	° ′ ″	° ′ ″	*Feet.*	*Dynes.*	*Dynes.*	*Dynes.*	*Dynes.*	*Dynes.*	*Dynes.*	*Dynes.*	*Dynes.*	*Dynes.*	*Dynes.*	*Dynes.*
Bhopāl ...	23 15 58	77 25 00	1,630	978·835	−0·153	+0·055	+0·007	978·682	978·737	978·689	978·711	+0·029	−0·026	+0·022
Kalianpur ...	24 7 11	77 39 17	1,763	978·892	−0·165	+0·059	+0·011	978·727	978·786	978·738	978·777	+0·050	−0·009	+0·039
Bina ...	24 10 41	78 11 46	1,355	978·896	−0·127	+0·046	±0·000	978·769	978·815	978·769	978·795	+0·026	0·020	+0·026
Guna ...	24 38 48	77 19 13	1,569	978·928	−0·147	+0·053	+0·007	978·781	978·834	978·788	978·807	+0·026	0·027	+0·019
Lalitpur ...	24 41 29	78 24 26	1,199	978·931	−0·112	+0·040	−0·003	978·819	978·859	978·816	978·814	−0·005	−0·045	−0·002
Sipri ...	25 25 52	77 39 25	1,533	978·982	−0·144	+0·052	+0·009	978·838	978·890	978·847	978·876	+0·038	−0·014	+0·029
Jhansi ...	25 27 2	78 33 43	858	978·983	−0·080	+0·029	−0·007	978·903	978·932	978·896	978·910	+0·007	−0·022	+0·014
Gwalior ...	26 13 57	78 12 49	658	979·039	−0·062	+0·022	−0·012	978·977	978·999	978·965	978·958	−0·019	−0·041	0·007
Dholpur ...	26 42 1	77 54 47	577	979·072	−0·054	+0·019	−0·015	979·018	979·037	979·003	978·999	−0·019	−0·038	−0·004
Agra ...	27 10 20	78 1 7	535	979·107	−0·050	+0·018	−0·018	979·057	979·075	979·039	979·056	−0·001	−0·019	+0·017
Muttra ...	27 28 25	77 41 48	562	979·129	−0·053	+0·019	−0·019	979·076	979·095	979·057	979·072	−0·004	−0·023	+0·015
Hathras ...	27 36 52	78 3 22	587	979·139	−0·055	+0·020	−0·020	979·084	979·104	979·064	979·075	−0·009	−0·029	+0·011
Aligarh ...	27 53 32	78 0 31	612	979·160	−0·057	+0·021	−0·021	979·103	979·124	979·082	979·075	−0·028	−0·049	−0·007
Khurja ...	28 14 19	77 51 53	649	979·186	−0·061	+0·022	−0·024	979·125	979·147	979·101	979·082	−0·043	−0·065	−0·019

* $\gamma_0 = 978{\cdot}030\ (1 + 0{\cdot}005302\ sin.^2\phi - 0{\cdot}000007\ sin.^2 2\phi)$.

TRIANGULATION (*vide* index map No. 12).

44. During 1912-13 No. 15 Party was employed in extending Principal and Secondary Triangulation.

(a).—Principal Triangulation.

(i).—The Sambalpur Series. This meridional series was continued from Latitude 22°, to which the operations of 1911-12 had carried it, and extended southwards through Sambalpur, the Orissa Feudatory States, and Khondmāls into Ganjām, reaching a Latitude of 19° 40′. Three more figures remain still to be observed before the series will be complete.

(b).—Secondary Triangulation.

(ii).—The Manipur Series. This series was commenced. It will connect the Assam Valley Series, in the neighbourhood of Golāghāt, with the northern end of the Manipur Meridional Series, a little to the west of Homalin.

(iii).—The Khandwā Series. This series along the parallel of 22° approximately, between the Khanpisūra Series in the neighbourhood of Khandwā, and the Great Arc Series near Badyūr, was fully completed.

(iv).—The Akola Series. A commencement was made on this meridional series which, it is intended, shall connect the Khandwā Secondary Series with the Bhīr Secondary Series in Longitude 76° 30′.

(v).—Bombay City and Island Operations. The triangulation commenced in 1911-12 to provide a basis for a large detail survey, was completed and supplemented by precise traverse work. About two fifths of the proposed traverse lines still remain to be completed.

(vi).—Kashmīr Secondary Operations. The triangulation commenced in the Summer of 1912 for the purpose of forming a connection between the Indian and Russian Systems of triangulation was completed in the Summer of 1913.

This series runs from Gilgit up the Hunza valley, over the Kilik pass, and across the Taghdumbash-Pāmir to the Beyik pass near which the Russian stations are situated.

The table below gives details regarding the work on the different series :—

SUMMARY OF PARTICULARS.

	TRIANGULATION.				TRAVERSE.
	PRINCIPAL.	SECONDARY.			
	Sambalpur.	Kashmir.	Khandwa.	Bombay.	Bombay City.
No. of Stations observed at ...	19	12	22	69	.....
,, ,, ,, newly fixed ...	17	..	20	.....	.....
,, ,, ,, built	17	...	20	.....	.....
Length of triangulation completed in miles	167	50	441	(not known)	.....
Length of triangulation remaining to be done	52	110	.....	.....	.....
Area of triangulation in sq. miles ...	5,014	650	1,710	(a) 79·95 (b) 15·36	.....
Theodolite used ...	T. & S.'s 12″ Micromr. No. V	T. & S.'s 6′ Micromr. No. 1403	T. & S.'s 8″ Micromr. No. 1315	T. & S.'s 8′ Micromr. No. 1055	T. & S.'s 8 Micromr. No. 1316
Number of triangles observed ...	19	11	22	84	.....
,, astronomical azimuths observed	2	..	.....	.....	.....
Maximum triangular error ...	0″·564	3″·96	3″·78	4″·30	.....
Average triangular error ...	0″·185	1″·47	1″·44	1″·95	.....
Mean closing error in Lat. ...	.....	.....	0″·465	.....	.....
,, ,, ,, Long. ...	.....	.....	0″·241	.....	.....
,, ,, ,, height ...	.....	..	1·9 feet	.....	.....
,, ,, ,, azimuth ...	.....	..	2″·424	.....	.....
,, ,, ,, log side, the unit being the seventh place of decimal	..	.....	239	.....	.....
TRAVERSE.					
Precision of results highest ...	.....	..	.....	.....	1 in 60,000
,, ,, average ...	.....	.....	.....	.....	1 in 12,000
Number of Stations ...	.....	.....	.....	.....	307
Total No. of miles of chaining ...	.....	.....	.....	.....	34·437
		Average height of stations above mean sea level, 14,706 feet.			

(a) Framework.
(b) Internal.

TIDAL OPERATIONS.

45. *No. 16 Party.*—Observations were taken by means of self-registering tide-gauges during the year, at the stations given in the following list :—

	Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1	Aden	1879 ...	Still working	34	
2	Karāchi ...	1868 ...	1880	*13 } 46	* Small tide-gauge working.
		1881 ...	Still working	33 }	
3	Bombay (Apollo Bandar) ...	1878 ...	,,	35	
4	Bombay (Prince's Dock) ...	1888 ...	,,	25	
5	Madras ...	1880 ...	1890	10 } 28	
		Restarted 1895	Still working	18 }	
6	Kidderpore	1881 ...	,,	32	
7	Rangoon	1880 ...	,,	33	
8	Moulmein ...	1880 ...	1886	6 } 10	
		Restarted 1909	Still working	4 }	
9	Port Blair	1880 ...	,,	33	

In addition to the above, tidal diagrams registered by a small river gauge at Chittagong and readings of high and low water taken during daylight on tide-poles at Bhaunagar and Akyab were supplied by the Port Officers concerned.

The 9 tidal observatories at work were inspected during the year and the registrations have, on the whole, been satisfactory, except at Madras, where the passage between the sea and the tide-gauge well was completely blocked with sand and the tidal observatory stopped working from the 10th August 1913. A new observatory at Madras is being built, but it was not ready by the 30th of September 1913.

Tidal observations during the coming year will be continued at all the above observatories.

46. In the following tables are given the annual and decadal percentages of errors in the predicted times and heights of high and low water at all the stations where observations have been taken :—

Percentage of errors in Predicted Times and Heights at open coast stations from Automatic Registrations.

Year.	Number of stations.	In Time. Within 15 minutes of actuals.		In Height. Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
1905	7	82	79	96	95	96	97
1906	6	85	81	96	97	94	95
1907	6	84	83	98	98	98	99
1908	6	84	84	98	97	99	99
1909	6	85	86	97	97	97	98
1910	6	81	83	98	98	95	96
1911	6	84	84	98	99	97	98
1912	6	82	82	97	98	97	98
Average of 10 years	.....	83	81	97	97	96	97

Percentage of errors in Predicted Times and Heights at riverain stations from Automatic Registrations.

Year.	Number of stations.	In Time. Within 15 minutes of actuals.		In Height. Within 6 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
1905	2	52	62	72	57	94	92
1906	2	59	53	74	64	92	95
1907	2	58	47	78	60	96	90
1908	2	58	52	77	60	97	92
1909	3	61	59	69	65	93	92
1910	3	57	52	63	71	89	94
1911	3	65	51	68	66	90	90
1912	4	70	58	74	62	94	91
Average of 10 years	....	58	56	72	63	93	92

LEVELLING OPERATIONS.

47. *No. 17 Party.*—Three detachments were employed on levelling operations during the past season.

48. *No. 1 Levelling Detachment* was employed *(a)* on the completion of the line Sargodha-Multān, *(b)* on a revision of the old line of levels Multān-Māhiwāla T. S., *(c)* on a revision of the old line Ambāla-Meerut-Delhi, along the main road, *(d)* on new levelling from Delhi along the road to Muttra, *(e)* on new levelling from Murree along the tonga road to Srīnagar (Kashmīr), with branch lines emanating from Srīnagar to Palgam *viâ* Islāmābād, to the Sind Valley, towards Bandapur, towards Shupiyan.

The out-turn amounted to 629 miles, and the heights of 8 primary, and 555 secondary bench-marks determined, including 5 Principal stations of the Great Trigonometrical Survey.

The line Sargodha-Multān completes the circuits, (1) Multān-Khemwāla-Segra-Darya Khān-Khushāb-Sargodha-Multān, 450 miles in length, and (2) Multān-Sargodha-Lahore-Ferozepore-Murghai-Khemwāla-Multān, a length of 795 miles, the closing errors being respectively 0·095 and 0·190 of a foot.

The new line Delhi-Muttra also completes the circuit Delhi-Meerut-Hāthras-Muttra-Delhi, the closing error being 0·158 of a foot in a length of 272 miles. These errors are deduced from differences of unadjusted orthometric heights.

49. *No. 2 Levelling Detachment* was employed on new levelling on the line *(a)* Comilla-Chittagong by road, *(b)* Brāhmanbāria-Pāchuriā, partly by road and partly along the railway line, crossing by the "Target" method the Meghnā, Lakhya and Dhaleswari rivers, and the Padmā or Ganges river by the "Vertical Angles" method, *(c)* Pāchuriā-Barisāl, by road and across country.

The out-turn amounted to 354 miles, and 18 primary, and 277 secondary bench-marks were connected, including 8 Principal stations of the Great Trigonometrical Survey.

In addition to the above, about 35 miles of single levelling were carried out at Darjeeling in the cantonments of Takdah and Lebong, and in the Happy Valley landslip area.

The line (1) Brāhmanbāria-Pāchuriā completes the circuit Porādaha-Pārvatīpur-Gauhāti-Akhaura-Pāchuriā-Porādaha, with a closing error of 2·706 feet, accepting the orthometric values of Porādaha and Pārvatipur as published in Great Trigonometrical Volume XIX B. The length of the circuit is 824 miles. The line (2) Comilla-Chittagong connects Pārvatīpur with the tidal bench-mark at Chittagong with an error of 1·082 feet, in a length of 643 miles, assuming that mean water level is 0·3 of a foot above mean sea level.

This shows that the greater portion of the error, *e.g.*, 1·624 feet in line (1), is on the line Akhaura-Porādaha, and may be due to errors in the single levelling from Pāchuriā to Porādaha which is to be revised by double levelling in the coming field season, and in the river crossings. For line (2) the most likely places for error to have crept in, are the river crossing at Dhubri, crossed by the "Tide-pole" method only, which is to be repeated by the "Vertical Angles" and "Target" methods, and the hill section over the Khāsi hills.

50. *No. 4 Levelling Detachment* was employed on new levelling in Burma, (*a*) from Henzada to Bassein along the left bank of the Ngawun river, (*b*) from Pegu to Mokpalin by road and railway, with branch lines along the Pegu-Sittang Canal, (*c*) from Prome to Taundwingyi *viâ* Allanmyo by road.

The out-turn amounted to 310 miles. The heights of 4 primary, and 220 secondary bench-marks were determined.

51. A section of No. 17 Party laid down on the ground and erected pillars on the new boundary between Naini Tāl District and Nepāl State, and also made a survey of the above boundary together with the boundary between Pilibhīt District and Nepāl State, the settlement of which is now under discussion.

MAGNETIC SURVEY.

52. *No. 18 Party.*—Two detachments, each under a Provincial officer, were employed on field work: they were engaged partly on detail survey and revision of the work of season 1901-02 and partly on revisiting repeat stations.

The officer in charge inspected Barrackpore and Toungoo base stations, observed at repeat stations and subsequently carried out a preliminary magnetic survey of Ceylon.

During the season the values of the magnetic elements were determined at the following:—

58 repeat stations,
19 old stations (revised),
42 new stations in Ceylon,
3 new stations in India,
20 new detail stations.

53. *Work during recess.*—The computation of the previous season's field work and the tabulation of the base station results for 1912 have been completed: the latter have for the first time been derived from the measurement of all available days instead of from only 5 quiet days per month as heretofore. One section has been employed throughout the year on the reduction of the declination data, which will shortly be completed.

The mean values of the magnetic elements for base stations for 1912 are as follows:—

Observatory.	Latitude & Longitude.	Dip.	Declination.	H. F.	V. F.
	° ′ ″	° ′	° ′	C. G. S.	C. G. S.
Dehra Dūn ...	30 19 19 N 78 3 19 E	N 44 8·9	E 2 25·9	·33248	·32244
Barrackpore ...	22 46 29 N 88 21 39 E	N 30 50·7	E 0 44·0	·37369	·22316
Toungoo ...	16 55 45 N 96 27 3 E	N 23 3·1	E 0 13·4	·38889	·16548
Kodaikānal ...	10 13 50 N 77 27 46 E	N 3 59·1	W 1 5·8	·37543	·02616

BASE LINE OPERATIONS.

54. *No. 19 Party.*—This party was only instituted on the 1st March 1913, and since the Base Line apparatus had not yet been received from England only a small amount of preliminary work in this connection has been possible.

In the meanwhile the officer in charge has been occupied in preparing further materials for marshalling the whole evidence of Indian geodesy in relation to problems concerning the constitution of the earth's crust.

PART III.

OFFICE WORK.

I.—HEADQUARTERS OFFICES.

MAP PUBLICATION OFFICE (*vide* index maps at end).

55. The classes of maps, for the publication of which the Headquarters Offices are responsible, may be enumerated as follows:—

(*a*)—Topographical maps on the scale of 1 inch = 1 mile.

(*b*)—Topographical maps on the scale of $\frac{1}{2}$ inch = 1 mile.

(*c*)—Topographical maps on the scale of $\frac{1}{4}$ inch = 1 mile.

(*d*)—Geographical maps on the one-millionth scale.

(*e*)—General maps on small scales.

(*f*)—Special maps.

The first duty of the offices is to publish the 1-inch, $\frac{1}{2}$-inch, and $\frac{1}{4}$-inch maps prepared by the field parties and circle drawing offices from the topographical surveys in progress.

56. *(a) The map of India on the scale of 1 inch = 1 mile.*—During the year 152 sheets of the new map have been received for publication and 222 sheets have been published.

All the areas surveyed up to the end of 1911-12 for the preparation of the new one-inch map of India have been published in the form of 1-inch sheets with the following exceptions,—30 sheets, including an area of approximately 8090·576 square miles; of these 30 sheets 29 are undergoing publication and the drawing of the other is in progress. The sheets of 1912-13 will begin to come in for publication early in 1913-14.

57. Index maps Nos. 4, 5, and 6 at the end of this report show the progress of the publication of the new one-inch map, and the table below gives the annual output of its sheets since the modern surveys were begun :—

Year.	1-Inch Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1905-06	...	...	...	...
1906-07	4	1	...	5
1907-08	16	15	22	53
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
1911-12	68	33	58	159
1912-13	104	60	58	222
Total printed ...	350	228	300	878
Total in programme ...	2,160	2,067	2,101	6,328
Number remaining for publication ...	1,810	1,839	1,801	5,450

58. One change which affects both the utility and appearance of the one-inch map has been introduced by the decision to shade the hills on sheets of mountainous country. This adds somewhat to the labour and time required for reproduction but a glance at the new one-inch sheets in the neighbourhood of Srīnagar, Kashmīr, (*e.g.*, sheet No. 43 $\frac{J}{16}$), will show that the change is decidedly an improvement.

59. In addition, 29 one-inch sheets prepared from modern revenue surveys have been received for publication, and 20 have been published as preliminary editions. Four special editions of one-inch sheets showing village boundaries have also been published.

60. To maintain the existing stocks, or to give effect to important changes due to the development of communications, &c., 10 modern, 4 preliminary and 38 old style one-inch sheets have been reprinted.

61. *(b) The half-inch map.*—So far only 2,959 square miles have been surveyed for the preparation of $\frac{1}{2}$-inch maps. The whole of this survey has been done during the field season of 1912-13 and the sheets should be received for publication in 1913-14.

62. *(c) The map of India on the scale of $\frac{1}{4}$ inch = 1 mile,* (vide *Index map No. 10*).—This map is prepared in "degree sheets" which include $1° \times 1°$, or the area covered by 16 one-inch sheets.

The following table shows the progress made in publication :—

Years of Publication.	Degree Sheets published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1911-12	2	1	1	4*
1912-13	3	1	1	5
Totals	5	2	2	9
Approximate number of degree sheets in India ...	170	140	140	450

* Only one sheet, the only one then published with hills shown by layers, was shown in the corresponding table on page 22 of the General Report for 1911-12. It has now been decided to include in this table all degree sheets prepared from modern surveys.

63. It has been decided to show the hills on degree sheets by a combination of contours, hill shading and layers. Small stocks of copies with the hills shown by contours and layers alone, (for scientific purposes), and with shade and contours alone will also be printed. Of the 9 modern degree sheets published, three are in accordance with these decisions.

64. Pending the preparation of the new degree sheets from modern surveys, 17 degree sheets have been prepared and published during the year from the maps of old surveys, 194 Atlas sheets and 6 district maps on the same scale have been reprinted including one new edition.

65. *(d) Geographical Maps on the one-millionth scale.*—The decision to produce these maps in layers, to which reference was made in para. 60 of the General Report of the department for 1911-12, has affected the output of the sheets of the India and Adjacent Countries Series to some extent. Four new sheets have been published during the year, 5 old sheets have been reprinted and the contouring of a few of the sheets already published as well as of the new sheets in hand is in progress.

66. One Indian sheet of the International Map of the World, scale 1:1,000,000 is in hand and will be published in 1914. (See paras. 61 and 62 of the General Report for 1911-12).

67. (*e*) *Small scale general maps.*—The engraved plates of the new 32-mile Map of India and Adjacent Countries have been completed. An outline edition without hills and a layered edition are being printed.

68. A new Railway Station Map on the scale of 32 miles to 1 inch showing every railway station in India and a new edition of the Railway, Road and Canal Map of India on the same scale have been published during the year. The last Annual edition of the Railway Administration Map of India, scale 64 miles to 1 inch, showing information up to the 1st of April 1913 was produced in May.

69. The first sheet, 'Southern Persia', of the Southern Asia Series of sheets on the scale of 1 : 2 million has been published. The 'Northern Persia' sheet is under publication and the fair drawing of the two other sheets, ('Afghānistān' and 'Baluchistān'), which include parts of Persia is in hand. The publication of the 'Southern Persia' sheet marks a new departure in the style of Indian Geographical maps. On it the heights above and below mean sea level have been shown by layers of colours and the hills have been shaded. A special experimental edition in different layer colouring and without shaded hills has also been printed as opinions of scientists differ regarding the advantage of shading hills on layered maps.

70. (*f*) *Special Maps.*—As usual a very large number of special maps and plans, diagrams and illustrations have been prepared for the different departments of Government, for Army Head Quarters and for officials throughout India, (see Part IV).

71. The number of maps issued during 1912-13 is considerably in excess of previous years, (see report of the Map Record and Issue Office on page 30), and there are other indications of a gradual but steady increase in the use of maps both for Government and private purposes in India.

72. The following departmental pamphlets have been printed at Calcutta this year:—

(*i*) A consideration of the contour intervals and colour scales best suited to Indian $\frac{1}{M}$ maps, by Captain M. O'C. Tandy, R.E.

(*ii*) Notes on the Vandyke or direct zinc process, compiled in the Photo.-Litho. Office under the direction of Colonel T. F. B. Renny-Tailyour, C.S.I., R.E.

A list of the departmental publications printed at Dehra during the year is given on page 35 in the report of the Dehra Office.

MAP RECORD AND ISSUE OFFICE.

73. The gross face value of the maps received from the printing offices during the year amounted to Rs. 3,18,793. This sum includes Rs. 14,392 and Rs. 5,809, the face value of maps printed in the Engraving Office and at Dehra Dūn respectively.

74. The following table shows the maps printed and received and their face values :—

Class of maps.	Scale.	Number of different maps of each class received.		Value.
		New Publications.	New Editions.	
				Rs.
(I) Geographical maps—				
(*a*) Maps of India	Various	2	1	29,900
(*b*) Southern Asia Series	1:2,000,000	1	...	1,800
(*c*) India and Adjacent Countries ...	1:1,000,000	4	5	4,253
(II) Topographical maps Degree Sheets.				
(*d*) Modern	1 inch = 4 miles	5	2	4,758
(*e*) Preliminary & Provisional ...	Do.	.....	1	1,700
(*f*) From Atlas Material	Do.	17	.....	5,100
(III) 1-inch sheets—				
(*g*) Modern	1 inch = 1 mile	222	10	1,18,675
(*h*) Do. (Preliminary Editions) ...	Do.	20	4	8,300
(*i*) Do. (Village Boundaries)	Do.	4	.....	1,600
(IV) Old Style Sheets	2 inch= 1 mile to 1 inch= 8 miles	8	38	20,088
(V) Atlas of India Series ..	1 inch= 4 miles	.....	194	42,542
(VI) Provincial Maps	1 inch=16 miles to 1 inch=32 miles	3	3	3,525
(VII) District Maps	1 inch= 4 miles	.....	6	2,400
(VIII) Administration Report Maps ...	1 inch= 8 miles	.....	20	900
(IX) Plans of Cities and Cantonments ...	Various	3	5	10,150
(X) Triangulation and Traverse Charts ..	Do.	1	1	92
(XI) Index Maps	Do.	34	3	2,518
(XII) Miscellaneous Maps	Do.	263	14	60,492
Total ...	.....	587	304	3,18,593
Corresponding figures for 1911-12 ...	.....	611	311	2,28,331

75. The total number of printed maps issued during the year was 327,311 of an aggregate value of Rs. 1,69,760. The details of the sales were as follows :—

Sales to	Number of maps.	Values.
		Rs.
Government officials	220,384	75,547
India Office	2,279	2,561
Departmental issues	71,054	62,371
Private individuals	28,957	24,503
Agents	4,640	4,778
Totals for 1912-13 ...	327,311	1,69,760
Corresponding totals for 1911-12 ...	288,633	1,39,270

No. 1 DRAWING OFFICE.

76. The Drawing Office continued its normal work of compiling and supplying material for the engraving of all the general small scale maps of the department and the fair drawing of such of them as are printed by heliozincography, the maintenance and correction of the record copies of all the maps of the department and the bringing up to date of old maps which had to be reprinted. During the year work was done on 29 sheets of the India and Adjacent Countries Series, on the scale of $\frac{1}{1,000,000}$, on 4 sheets of the Southern Asia Series, on the scale of $\frac{1}{2,000,000}$, and on 41 sheets of the General maps of India on various scales.

77. The preparation of degree sheets from old atlas sheets has been continued and 30 such sheets have been taken in hand.

Of maps, on various scales, which had to be reprinted, 105 were worked on during the year.

Corrections or additions were made to 60 sheets, on various scales, which had been drawn by parties or circles.

Of index maps, provincial and district maps, and large scale plans of cities and cantonments, 109 have been in hand and 40 sheets of miscellaneous specimens, symbols, &c., for departmental use were also worked on. A large amount of extra departmental mapping in 49 sheets has been undertaken; included in this were a new edition of the Postal Map of the United Provinces, Maps of Fort William and of Tenasserim, also many maps and plans for Census Officials, Railways, Telegraph, Educational and other authorities. (See pages 42, 43.)

The examining section has dealt with 637 cases during the year in addition to a great deal of miscellaneous work.

78. The work of the 'office copy' or record section continued to be heavy, new railways and canals and additions to main roads, and changes in boundaries, were marked on the record copies of the maps of the department; this work affected 3,069 sheets, 1,111 new record copies were examined and filed during the year and 23,833 coloured maps examined before issue to the public.

In addition to this normal work of the office copy section, 114 pages of traverse data were supplied to Settlement Officers, Engineers and others, attested traces of certain large scale surveys were supplied for use in court proceedings and information regarding systems of survey, boundaries, &c., were supplied to settlement, political, cantonment, departmental and other officers.

ENGRAVING OFFICE.

79. The new 5th edition of the 32-mile Map of India, in 12 sheets, was completed during the year.

Corrections have been made to the 64, 96, 128, 192 mile maps of India and a new map on the 128-mile scale has been published.

The engraving of the first degree sheet, 38 N, based upon surveys subsequent to 1905, was practically completed and this map will be published early in 1914.

Work was continued on five sheets 34, 47, 53, 83, 94 of the $\frac{1}{1,000,000}$ series and on one sheet of the International Map on the same scale. In addition, work was put in hand on sheet 63, and plates for colour printing of sheets 47, 53, 63 of the $\frac{1}{1,000,000}$ scale begun.

Numerous provincial, miscellaneous, and index maps have been prepared or corrected. Index maps for the whole of India and Adjacent Countries will be completed in 1913.

PHOTO.-LITHO. OFFICE.

80. There has been an increase of both departmental and extra departmental work during the year and this has been satisfactorily dealt with, a comparatively small expenditure on overtime charges having been incurred.

Two hundred and fifty-two sheets in modern form were published, including preliminary and provisional editions, new publication and reprint editions to replenish stock. Of these 233 were in colours (222 new sheets, 1 preliminary sheet and 10 reprints) and the number of new 1-inch sheets published shows an increase of 63 over 1911-12 and of 42 over any former year.

The total number of impressions pulled exceeds that of any former year by four lakhs.

81. Good progress has been made and much experience gained in the matter of printing layered maps. Among the minor improvements in this direction has been that obtained by etching the successive plates in relief. Six layered maps have been printed and published during the year and three sheets of the 32-mile layered map of India have been proved.

82. A few changes of importance have been made in the Photo. Branch. The conversion of the large camera to carry the Zeiss "Planar" lens purchased last year to an iron base stand has enabled that lens to be brought into use, while the strengthening of the floor with iron girders below the runners of the camera stands has done away with the vibration which formerly gave trouble.

No changes have been made in the methods and formulæ with the exception of the introduction of a screen photogravure process which has been found useful for certain subjects.

The installation of electric light throughout all sections of the office now enables all hands to work at night should it at any time be found necessary to do so.

During the year under report the Stores Section of the Office has been reorganised. The section is, however, working under a disadvantage owing to the very restricted accommodation for stores.

TABULAR STATEMENT OF OUT-TURN OF PHOTO.-LITHO OFFICE.

1	2	3	4	5	6	7	8	9
Year.	Cost of office.	Value of out-turn at cost-rates.	Recovered in cash or by book-debit.	Number of impressions pulled. *	NUMBER OF MAPS PRINTED. Departmental.	Extra departmental.	Total.	REMARKS.
	Rs.	*Rs.*	*Rs.*					
1910-11 ...	1,64,193	1,77,900	50,693	1,383,147	2,559	1,104	3,663	
1911-12 ...	1,47,867	2,01,584	24,904	1,564,496	2,686	1,263	3,949	
1912-13 ...	1,64,699	2,39,940	27,214	1,966,458	3,656	2,010	5,666	

* This as in statements of previous years only includes litho. impressions.

In addition, there were 51,370 half-tone pulls and 530,280 line-block pulls, (chiefly Weather Charts).

as against { 60,056 ,, ,, and 437,820 ,, ,, in 1911-12.
{ 102,900 ,, ,, and 111,300 ,, ,, in 1910-11.

The output of the Type Section is not included in the above statement.

The Type Section published 8,408 pages or items, 1,343,465 copies, 2,608,591 impressions.

as against { 7,988 ,, or ,, 1,131,012 ,, 2,014,766 ,, in 1911-12.
{ 14,604 ,, or ,, 1,235,161 ,, 2,104,755 ,, in 1910-11.

MATHEMATICAL INSTRUMENT OFFICE.

83. During the year under report, *viz.*, from 1st April 1912 to 31st March 1913, there was a shrinkage in the demands made on this office, compared with those of the preceding year, as the following table shows with the result that against a profit of Rs. 6,204 exhibited by the Profit and Loss statement of 1911-12, that for 1912-13 shows a loss of Rs. 7,055, which, however, includes over Rs. 5,500 loss on the sale of unsuitable hydrometers.

Value of Instruments issued to Public Officers.

1910-11.	1911-12.	1912-13.
Rs.	*Rs.*	*Rs.*
2,65,184	3,25,633	2,81,315

84. On the other hand, there was a marked improvement, as the ollowing table will show, in the value of the work done, and the Profit and Loss statement shows a gain of Rs. 2,887 against the loss of Rs. 4,718 shown by that for 1911-12.

Value of work done in the workshop.

1910-11.	1911-12.	1912-13.
Rs.	*Rs.*	*Rs.*
2,01,329	1,74,871	2,15,328

85. The following figures show the number of employés at the end of each of the last 3 years:—

Number of employés at the end of each of the last three years.

1910-11.	1911-12.	1912-13.
318	330	338

86. The following table shows the average number of employés and their pay:—

Average number of employés and their pay.

1910-11.	1911-12.	1912-13.
296 at Rs. 59,836	297 at Rs. 62,981	301 at Rs. 68,625

87. It may be noted that as pointed out in the previous years' reports, certain standing charges (representing supervision, rent, interest on plants and material, depreciation, clerical labour, &c.), have got to be incurred irrespective of the work coming to the office, and consequently, the so-called profit and loss in connection with the working of the Mathematical Instrument Office depends on the demands received for instruments to be supplied, and for work to be done. In calculating profit and loss a percentage is allowed to be taken as credit (25% over book value in the case of issues and 10% in the case of work done), and an increase of demands means an increase in the amount of this percentage, resulting in probably a gain; and a shrinkage of demands means a reduction in the amount of the percentage, resulting in probably a loss, the standing charges remaining the same in both cases. Increased debit has arisen of late years, due to the necessity of writing down prices, which mean decrease and loss.

88. Below are given the usual comparative figures for the last three years:—

	1910-11.	1911-12.	1912-13.
	Rs.	*Rs.*	*Rs.*
Total issues to Public Offices as shown in the Profit and Loss statements of stores.	2,65,185	3,25,633	2,81,315
Value of repairs to instruments received for repairs and returned in a serviceable condition.	64,156	55,941	64,452
Value of instruments received from Government Officers when no longer required.	33,428	37,228	57,267
Book value of the stock of instruments, &c., in Serviceable Stores.	9,20,925	7,46,047	6,45,081
Book value of the stock of instruments, &c., in Repairable Stores.	69,371	70,460	72,452
Total value of work done in the Workshop ...	2,01,330	1,74,871	2,15,328
Value of instruments manufactured in workshop for Serviceable Stores.	61,698	61,431	71,188
Value of instruments purchased locally ...	2,880	4,578	6,206
Value of instruments and materials obtained from England through the Director General of Stores.	40,844	47,148	57,647

89. During the year the stock of all the three stores (the Serviceable, the Repairable and the Material Stores), was twice taken, and the discrepancies noticed have been adjusted. The 2nd stock-taking of the repairable stores, however, was done in April 1913 instead of in March.

90. Apart from the ordinary repairs and manufactures, the following few special works done may be mentioned :—

(a) New pattern of brass sight rules and rectangular compasses were made up, and were reported on favourably. More have been indented for the coming season.

(b) Aluminium plane-tables were made for use during the last field season, but they did not prove successful owing to the aluminium bracings not being sufficiently strong to resist sag caused by the Surveyors' weight on the edge of the table. Several more aluminium plane-tables have been made up for trial again during the coming season, with the bottom strengthened in different ways to eliminate the above defect. One has been strengthened with Duralumin.

(c) Two experimental aluminium G. T. staves were constructed to a specification by the Superintendent of the Trigonometrical Survey.

(d) For the coming season, an experimental water level for use with G. T. staves has been constructed to a design by Captain V. R. Cotter, I.A.

(e) Some telescopic clinometers have been made up to a design sent in by the Superintendent, Southern Circle.

(f) Trial is being given to the skim-milk product called 'Syrolit', as a substitute for ebonite and ivory, for set squares and scales.

H.—DEHRA DŪN OFFICES.

SPECIAL OPERATIONS.

91. The new apparatus for the comparison of standards of length has arrived, and is now in process of erection.

92. A portable mast, 150 ft. high, was made and erected in the Survey Office compound. The mast was primarily designed to support an electrical apparatus for the determination of air temperature at various heights, which is now being made in London, but it would also be suitable for supporting a wireless telegraphy aerial, or to serve as a triangulation signal.

93. The daily meteorological observations were continued as usual up to December 1912. From 1st January 1913 the readings of the earth thermometers have been discontinued, and the readings of the barometer and of air-temperatures are being taken once daily, at 2 p. m. standard time, instead of twice as heretofore. Simultaneous readings have been taken at Mussoorie to give data for temperature gradient and refraction.

94. During the year under report the Seismograph has worked satisfactorily; a list of the earthquakes recorded in 1912-13 is published in the Records of the Survey Department, Vol. V.

95. Photographs of the sun have been taken on 339 days, the sun being obscured by clouds on the remaining days.

COMPUTING OFFICE.

Geodetic work.

96. Numerous computations comprising conversion of co-ordinates for trans-frontier degree triangulation charts; computations in connection with Professional Paper No. 14; deduction of dynamic and orthometric heights of levelling lines Khushāb to Lahore, Amkhās to Multān, Sargodha to Multān, Multān to Māhiwāla and Prome to Rangoon; adjustment of Bhīr, Villupuram and Khandwā secondary series, reduction of latitude observations taken by Lieutenants Almond and McKay at seven stations between Dehra Dūn and Mussoorie, and the preparation of certain tables for the Records have been carried out.

97. Thirteen spirit levelling pamphlets and 27 triangulation charts passed through press; data for 40 charts were compiled and compared.

The following publications have been printed :—

(*a*) "A note on the representation of Hills" by Major F. W. Pirrie, I.A.

(*b*) Departmental Paper No. 1. "A consideration of the most suitable form of type for use on maps", by Captain M. O'C. Tandy, R.E.

(*c*) Departmental Paper No. 2. "A review of the boundary symbols used on maps of various countries," by Captain M. O'C. Tandy, R.E.

(*d*) Departmental Paper No. 3. "Extract from the new map of Italy, scale 1:100,000", by Luigi Giannitrapani. (Translated from the Italian, by Major W. M. Coldstream, R.E.).

(*e*) Departmental Paper No. 4. "A report on the practice of town surveys in the United Kingdom and its application to India", by Major C. L. Robertson, C.M.G., R.E.

(*f*) "The Thompson Stereo-plotter and its use, with notes on the field work", by Lieutenant K. Mason, R.E.

(*g*) Professional Paper No. 14. "Formulæ for Atmospheric Refraction and their application to Terrestrial Refraction and Geodesy", by J. deGraaff Hunter, M.A.

Data from the original records were supplied to 50 officers, and a large number of requisitions for forms were attended to.

Geographic Work.

98. Some topographical triangulation has been finally adjusted and more work of this sort is in hand.

The 4th Edition of "Routes in the Western Himâlaya and Kashmîr" is in course of preparation.

Preservation of Trigonometrical Stations.

99. 1,266 stations were repaired by the district officers at a cost of Rs. 6,205-8-10. Out of 347 districts from which reports are annually due, 18 failed to make returns.

No. 2 DRAWING OFFICE.

100. The following table shows the volume of work undertaken :—

Class of maps.	Number of sheets in hand.	Number of sheets drawn and sent to press.
Scientific diagram Layer System, 1 inch=8 Miles ...	.....	1
Geographical maps, Layer System, scale $\frac{1}{1,000,000}$ ...	3	...
Do. do. 1 inch=32 Miles	.....	6
Do. do. smaller scale ...	3	1
Miscellaneous indexes, plans and diagrams, &c. ...	13	6
Levelling charts	.....	11
Chart of Triangulation, degree sheets	25	17
Extra departmental maps, plans, indexes, &c. ...	1	6

PHOTO.-ZINCO. SECTION.

101. 1,973 maps and diagrams were photographed during the year against 1,550 in 1911-12.

The number of impressions pulled was 236,766 against 289,116 in the previous year. The lithographic machine was employed throughout the year in printing the maps of Dr. Stein's exploration, Forest maps, triangulation and levelling charts. The last sheet of Dr. Stein's maps was completed at the end of May.

The letter-press was employed throughout the year in printing departmental forms, the number of impressions pulled was 377,027 against 265,615 in the previous year.

FOREST MAP OFFICE.

102. The total number of maps issued, both to officials and the public, during the year amounted to 9,607, a decrease of 846 on last year's total. The gross face value of these maps was Rs. 17,223 and the net amount realised from sales was Rs. 3,191. Of this amount Rs. 2,067 was recovered by book-debit and Rs. 1,124 by cash from sales to private individuals and trading companies. The total sum realised from sales in the previous year was Rs. 2,681, so that in actual sales there has been an increase of Rs. 510 during the year under review. The number of maps and field sections received for storage during the year was 6,099, besides 259 computation volumes, angle-books and traverse field-books and 73 triangulation and traverse charts.

103. The following table shows, in abstract form, the work dealt with by the Office :—

Class of map.	Number of Sheets.		
	In hand.	Drawn and sent to press.	Published.
1-inch, 2-inch, and 4-inch maps of Forest Surveys	194	62	82
Provincial, Divisional, and District Forest maps ...	14	4	5
Working Plans and Miscellaneous maps ...	8	24	30
Totals ...	216	90	117

III.—CIRCLE AND LOCAL DRAWING OFFICES.

No. 3 DRAWING OFFICE (NORTHERN CIRCLE).

104. The routine work of the office was the final examination of 1-inch sheets, drawn by the various parties in the circle; and the drawing of degree sheets.

The following were finally examined and sent for publication during the current year:—69 1-inch sheets, 3 degree sheets and one cantonment map.

At the end of the year under report there were 11 degree sheets in hand, but no arrears of 1-inch drawing, of sheets which had been surveyed in 1911-12.

No. 4 DRAWING OFFICE (SOUTHERN CIRCLE).

105. Thirty-four 1-inch sheets were received from field parties and out of these thirty-three were finally examined and sent for publication and only one sheet was with held pending settlement of some questions regarding details and boundaries. The only sheet reported as surveyed in 1911-12 which was not submitted for publication before 30th September 1913 was 58 $\frac{B}{12}$.

Three degree sheets were completed and sent for publication and seven more were in hand at the close of the survey year. Twelve pupil draftsmen were trained and assistance was given to parties to complete their current season's mapping.

106. The Photo.-Zinco. Section undertook the photographic and zincographic work required by the circle and the following is a summary of the work done:—

Number of reproductions to full scale	1
Enlargements	121
Reductions	213
Vandyked	67
Total ...	402

No.5 DRAWING OFFICE (EASTERN CIRCLE).

107. The chief work of the office during the year was the examination of the parties' one-inch sheets and the drawing of degree sheets.

In addition to the draftsmen lent to the parties during the recess season six draftsmen were permanently transferred to form the nucleus of a drawing office in Maymyo attached to No. 10 Party. It is intended that in future that office will draw all Burma degree sheets.

During the year 57 one-inch sheets were submitted for publication including 4 sheets which were completed to margin from additional material in this office. In addition 10 degree sheets were drawn in this office and submitted for publication, three contain material from old surveys which were completed to margin and on one sheet stump shading was executed.

One cantonment sheet was submitted to the Superintendent of the Trigonometrical Survey.

26 degree sheets are now in hand; of these seventeen cover the areas recently surveyed in years 1911—13 by the Abor, Mishmi and Miri Mission and Exploration parties: it is intended to publish these in degree sheet form in addition to the various special provisional maps already prepared.

BIHAR AND ORISSA DRAWING OFFICE.

(Standard Mapping Section).

108. The following 29 one-inch maps with a mapped area of 5,879·40 square miles have been submitted during the year for the publication of a preliminary edition of each:—Nos. 64 O/13, 72 C/14, 72 G/7, 11, 15, 72 L/41, 12, 15, 16, 72 O/12, 16, 72 G/10 & 14, (old No. 145 in four sections completed to margin), 73 C/1, 4, 5, 7, 72 P/3 to 15, the last thirteen, *i.e.*, P/3 to 15, have also been submitted for the preparation of prints for supplementary survey.

109. The following 35 one-inch sheets which have been completed for surveyed areas are being withheld until the cadastral maps of districts Jalpaiguri, Gayā, Palāmau, Hazāribāgh, Mānbhūm and the neighbouring districts of the United Provinces are received:—

63 O/7, 8, 11, 14, 15, 63 P/5, 6, 10, 14, 64 O/9, 10, 72 C/2, 6, 8, 10, 11, 12, 15, 16, 72 D/1, 2, 5, 72 G/3, 4, 8, 12, 16, 72 H/15, 73 I/1, 2, 3, 9, 13, 78 B/6, 8.

110. The following 58 one-inch sheets representing an area of 9,247·36 square miles are being got ready for publication either of a preliminary edition or for revision survey:—

63 O/12, 16, 63 P/9, 13, 64 K/12, 16, 64 L/9, 13, 64 O/4, 6, 7, 8, 11, 12, 14, 15, 16, 64 P/1, 5, 72 C/3, 4, 7, 73 A/11, 12, 15, 16, 73 C/2, 3, 73 E/1 to 16, 73 J/1, 2, 3, 5, 6, 7, 10, 11, 12, 14, 15, 16, 73 M/1, 5.

111. The following examination, correction and colouring work has also been completed:—

(*a*) 26 uncorrected proofs of one-inch sheets have been examined and corrected.

(*b*) Fiscal limits and cultivation have been coloured on 48 unpublished black prints of one-inch sheets.

(*c*) 24 published black prints of one-inch sheets have been coloured.

112. The drawing of the following maps has also been completed in the Standard Mapping Section:—

(*a*)	Darjeeling Municipality	60-inch map.
(*b*)	„ „	10 „ „
(*c*)	„ „	20 „ „
(*d*)	Map of Happy Valley survey, Darjeeling ...	20 „ „
(*e*)	Lebong Cantonment map survey ...	30 „ „
(*f*)	Takdah „ „ „	30 „ „

(*a*) to (*c*) were prepared for the Darjeeling Municipality and will be paid for by that body.

(*d*) is being prepared for the Public Works Department, and will be paid for by that department.

(*e*) and (*f*) are being prepared under the orders of the Surveyor General for the Military Department, and will be paid for by the Surveyor General.

PART IV.

WORK FOR OTHER GOVERNMENT DEPARTMENTS.

113. As in previous years, the Riverain Detachment of the Northern Circle was exclusively employed on the Riverain traverse and rectangular surveys required by the Punjab Government (*vide* page 8).

114. At the request of the Māler Kotla Durbar, a 6-inch survey of Māler Kotla and environs was carried out by No. 2 Party and the cost of this survey, *viz.*, Rs. 600, was borne by the above State.

The area surveyed was 10·50 square miles.

115. No. 20 party (cantonment) has been organised and is at present devoting its time to making surveys of different military cantonments required by the Army Department. Its report will be found on page 18.

116. An officer has been deputed to the Bombay Government to carry out the survey of an experimental area of 200 acres in Bombay so that experience may be gained to prepare an estimate of the time and cost of surveying the whole city.

117. The Mathematical Instrument Office supplies and repairs instruments for every Government department in India including the Army Department.

118. Various forest surveys were carried out for Local Governments, &c. (*vide* page 16).

119. An officer of No. 11 Party was employed in giving practical training in topographical surveying to six superintendents of the Burma Land Records Department in two batches for two months each.

120. Traces of the area surveyed by No. 11 Party as it progressed and several copies of blue print enlargements of plane-table sections, mounted and inked up, were supplied to the Deputy Commissioner of the Tavoy district for allotting mining concessions and settling disputes.

121. The series of secondary triangulation in Kashmīr for the purpose of connecting with the Russian triangulation, was completed during the year (*vide* page 21).

122. Exploration work for the Foreign and Political, and Army Departments was continued on the North East Frontier by the Abor, Mishmi and North Burma Exploration Survey Detachments (*vide* page 15). Captain Morshead accompanied Captain Bailey of the Foreign and Political Department on his journey up the Tsan Po.

123. The boundary between Nepāl and British territory along the Sārdā River was surveyed and demarcated as described in para. 51, page 24.

124. A surveyor accompanied the late Captain Pritchard and Captain Waterfield on their journey from Assam to Burma through Hkamti Long.

125. Heights observed in Arabia by Captain Leachman of the General Staff were reduced by the Computing Office, Dehra Dūn.

126. Certain computations were done for the Commissioner of Settlement and Land Records, Burma.

127. The geographical co-ordinates of a number of places in India were supplied to the office of the Connaissance des Temps, Paris.

128. The remainder of the maps of Dr. Stein's Explorations in Chinese Turkestān and Western China, 1906—08, were completed and reproduced at Dehra Dūn.

129. A section of No. 6 Drawing Office (Simla) is employed solely on miscellaneous work for the Military and Foreign and Political Departments, and has turned out a large number of maps.

130. The reproduction, for other departments, of maps, plans, and illustrations that do not require to be redrawn, does not interfere with the normal work of the Survey of India and is always undertaken when asked for. On the other hand, the amount of drawing and compilation that can be done for extra-departmental purposes is limited, and is necessarily confined to urgently required and important work.

131. During the year maps, plans, or illustrations were reproduced for the following departments and offices:—

Public Works Department, Government of India.

Home Department, Government of India

Finance Department, Government of India.

General Officers Commanding, Divisions and Brigades.

The Director-General of Military Works.

The Director-General of Commercial Intelligence.

The Director-General of Observatories.

The Director-General of Archæology in India.

The Director-General, Indian Medical Service.

The Director, Geological Survey of India.

The Director, Botanical Survey of India.

The Director of Land Records, Punjab.

The Consulting Architect to the Government of India..

The Officer on Special Duty for Enquiry into Prices.

The Engineer Officers on Special Duty, Delhi.

The Chief Inspector of Mines in India.

The Indian Museum.

The Superintendents, Government Printing.

The Superintendent, Hindu and Buddhist Monuments.

The Controller of Patents and Designs.

The Great Indian Peninsula Railway.

The East Indian Railway.

The Bengal-Nagpur Railway.

The Eastern Bengal State Railway.

The Bengal and North-Western Railway.

The Karāchi Extension Railway Survey.

Sanitary Commissioners.

The Census Commissioner for India.
Chief Engineers.
Forest Department.
Police Department.
Post and Telegraph Department.
Agricultural Department.
Government Epigraphist.
The Inspector-General of Civil Hospitals.
The Military Secretary to His Excellency the Viceroy.
The Revenue and Judicial Commissioner, Baluchistān.
Linguistic Survey in India.
Civil Engineering College, Sibpur.
Gun and Shell Factory, Cossipore.
Coronation Durbar Committee.

Some work was also done for various public bodies and societies.

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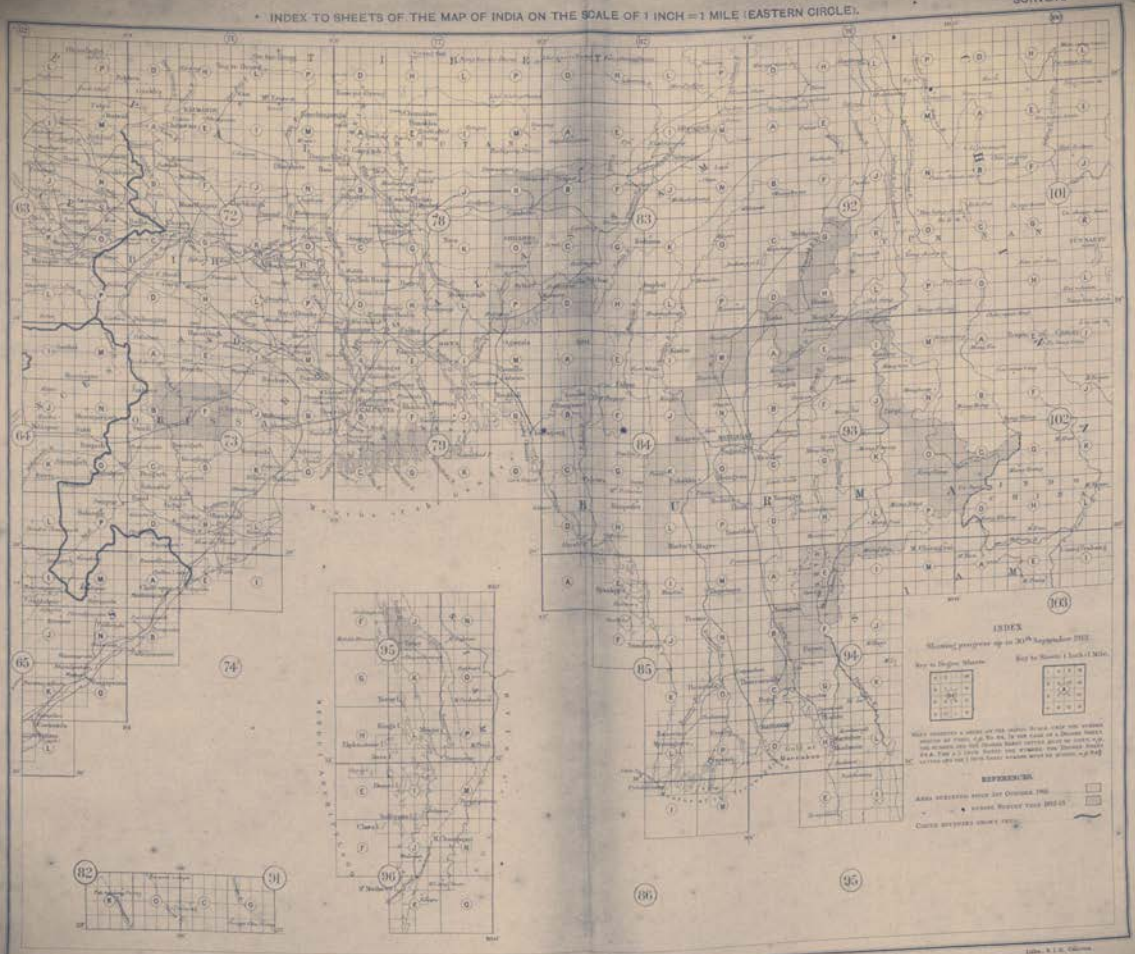
INDEX TO SHEETS OF THE MAP OF INDIA ON THE SCALE OF 1 INCH = 1 MILE (SOUTHERN CIRCLE).

INDEX TO SHEETS OF THE MAP OF INDIA ON THE SCALE OF 1 INCH = 1 MILE (EASTERN CIRCLE).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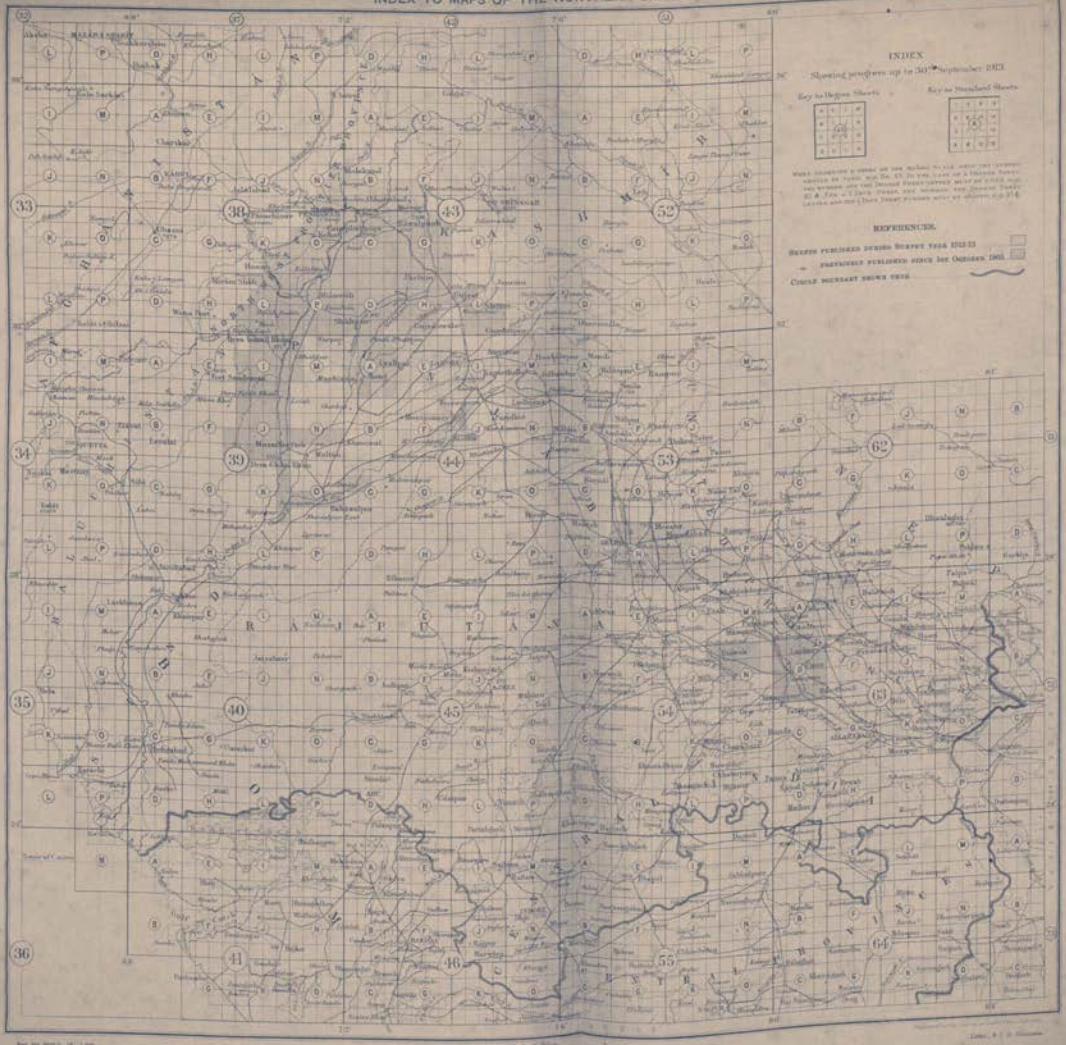

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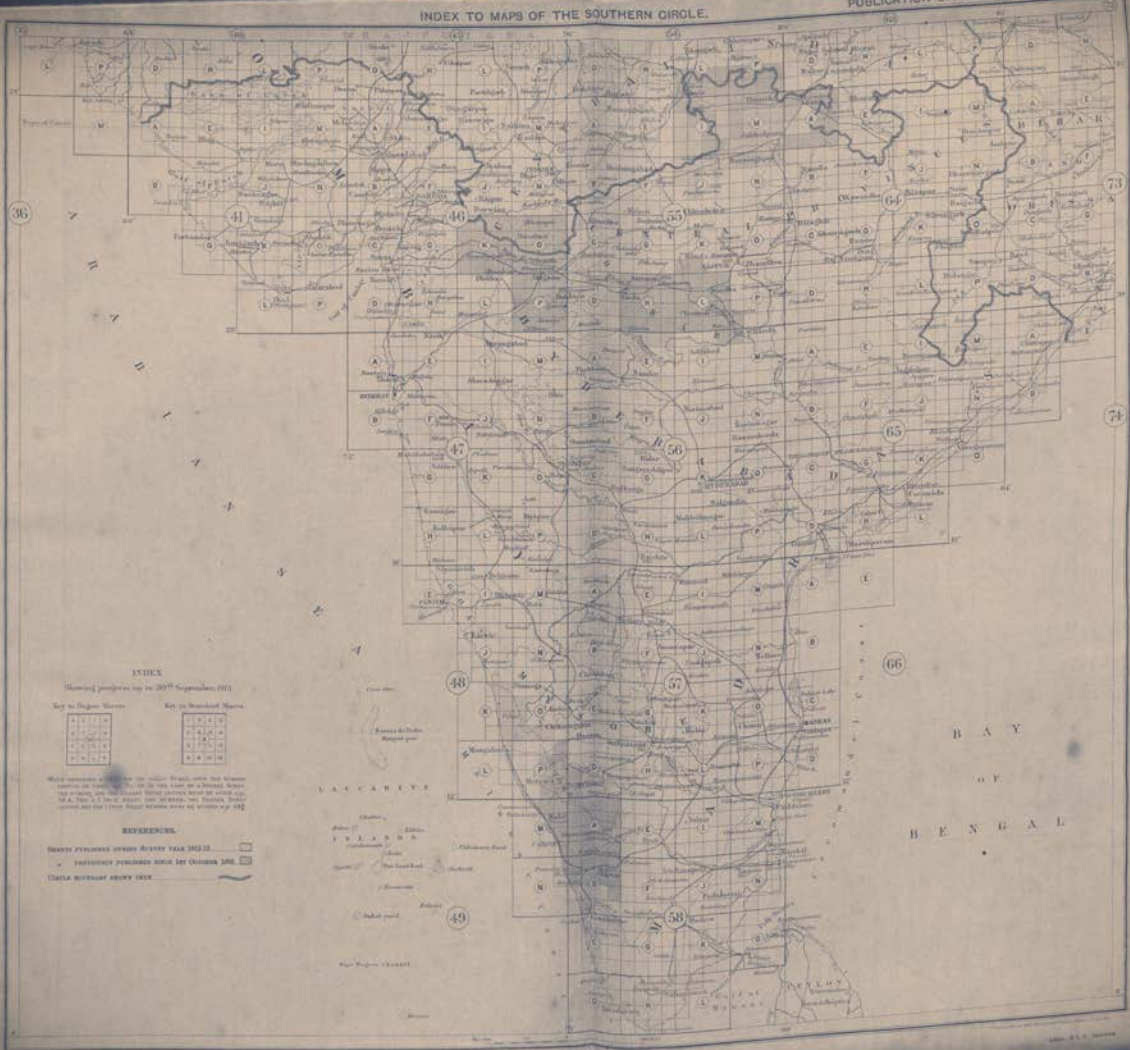

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PUBLICATION ON THE ONE INCH SCALE.

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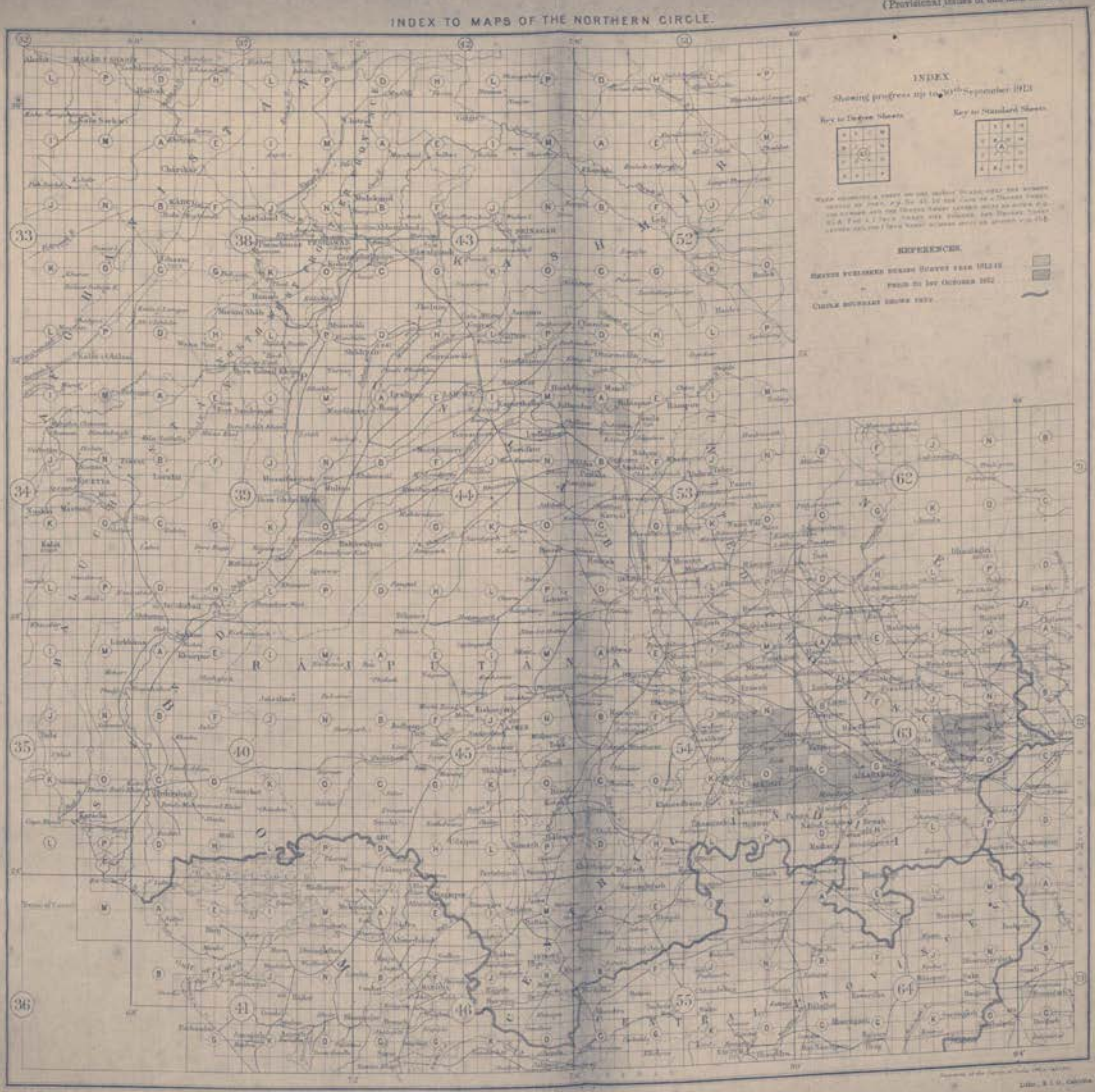

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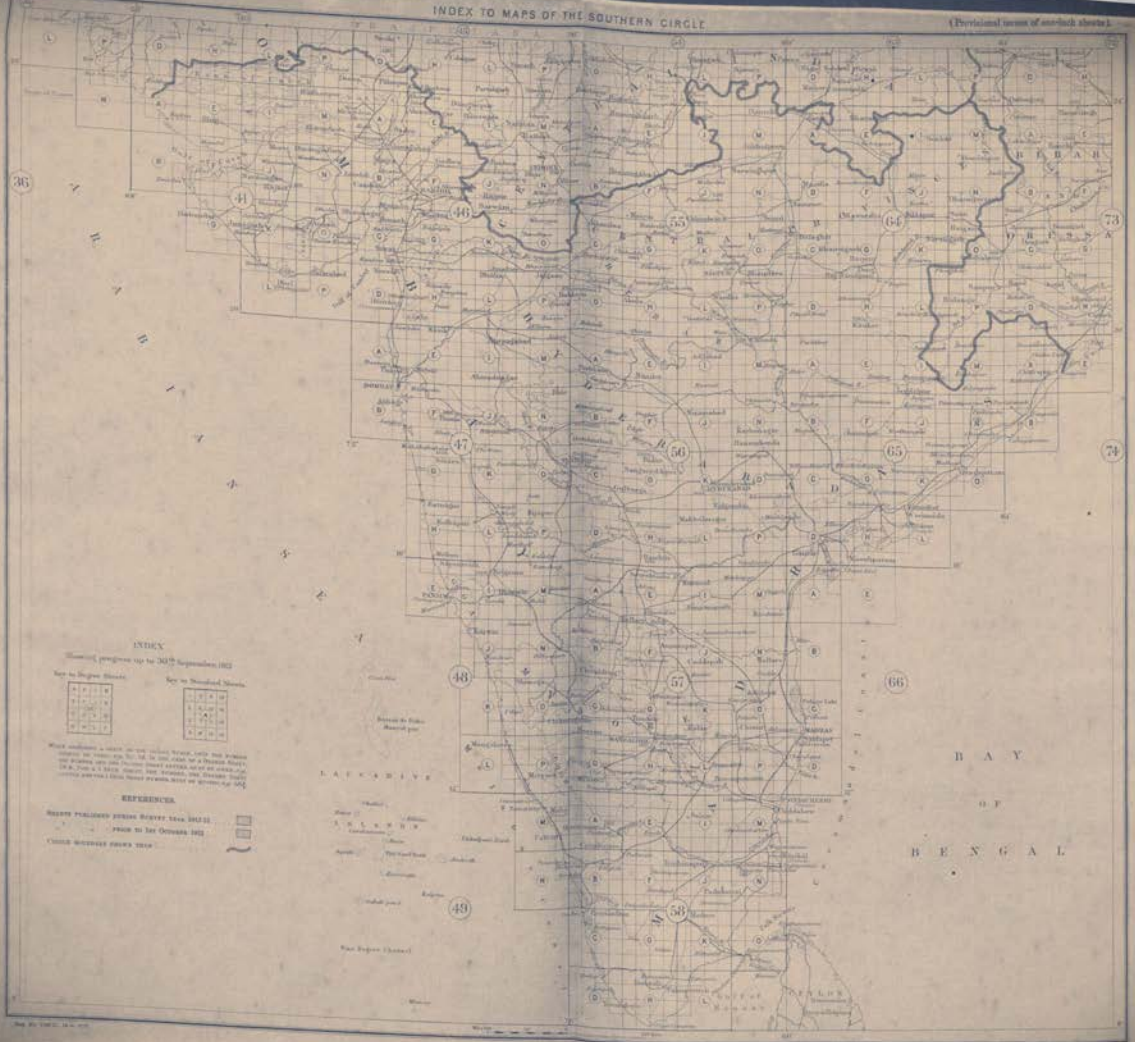
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Palk Bay
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Mannar Island
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Sivaganga
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Dindigul
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Andipatti
Vadipatti
Usilampatti
Melur
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Virudhunagar
Sattur
Kovilpatti
Tuticorin
Srivaikuntam
Tiruchendur
Nanguneri
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Tinnevelly
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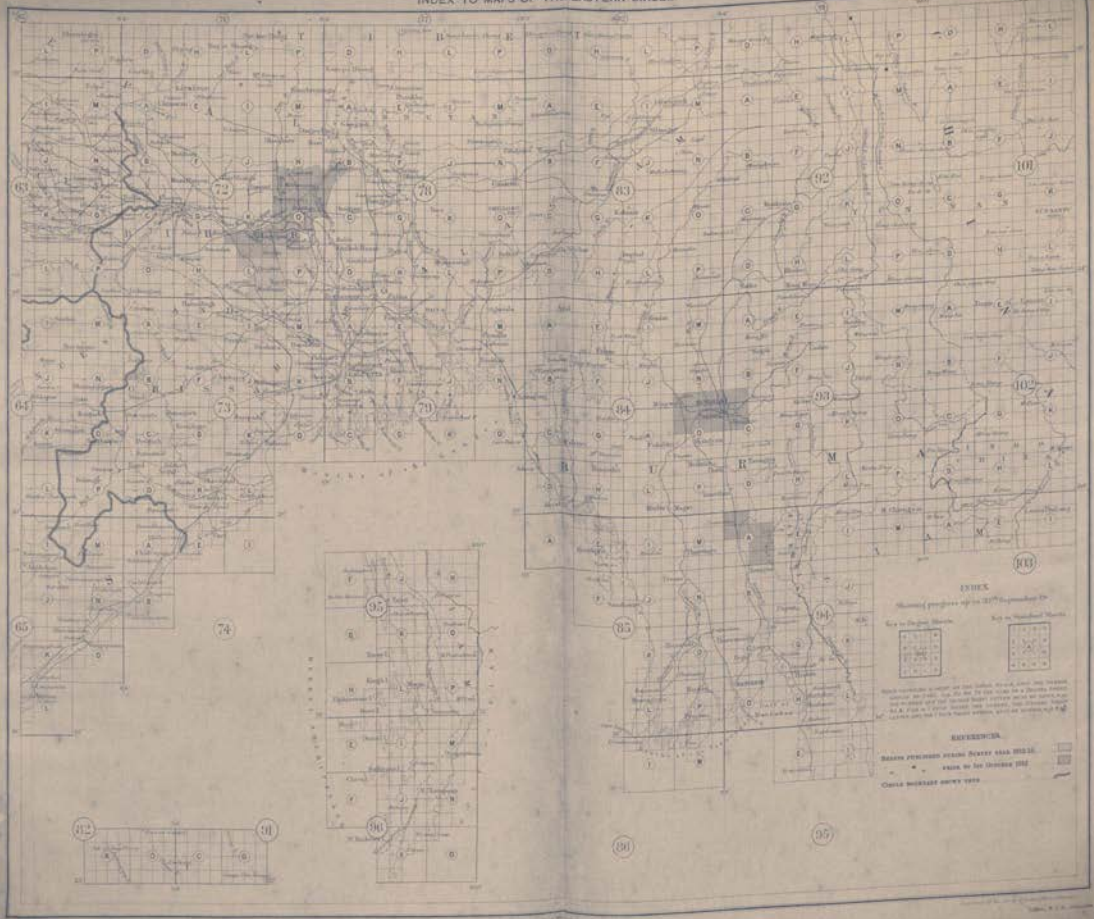

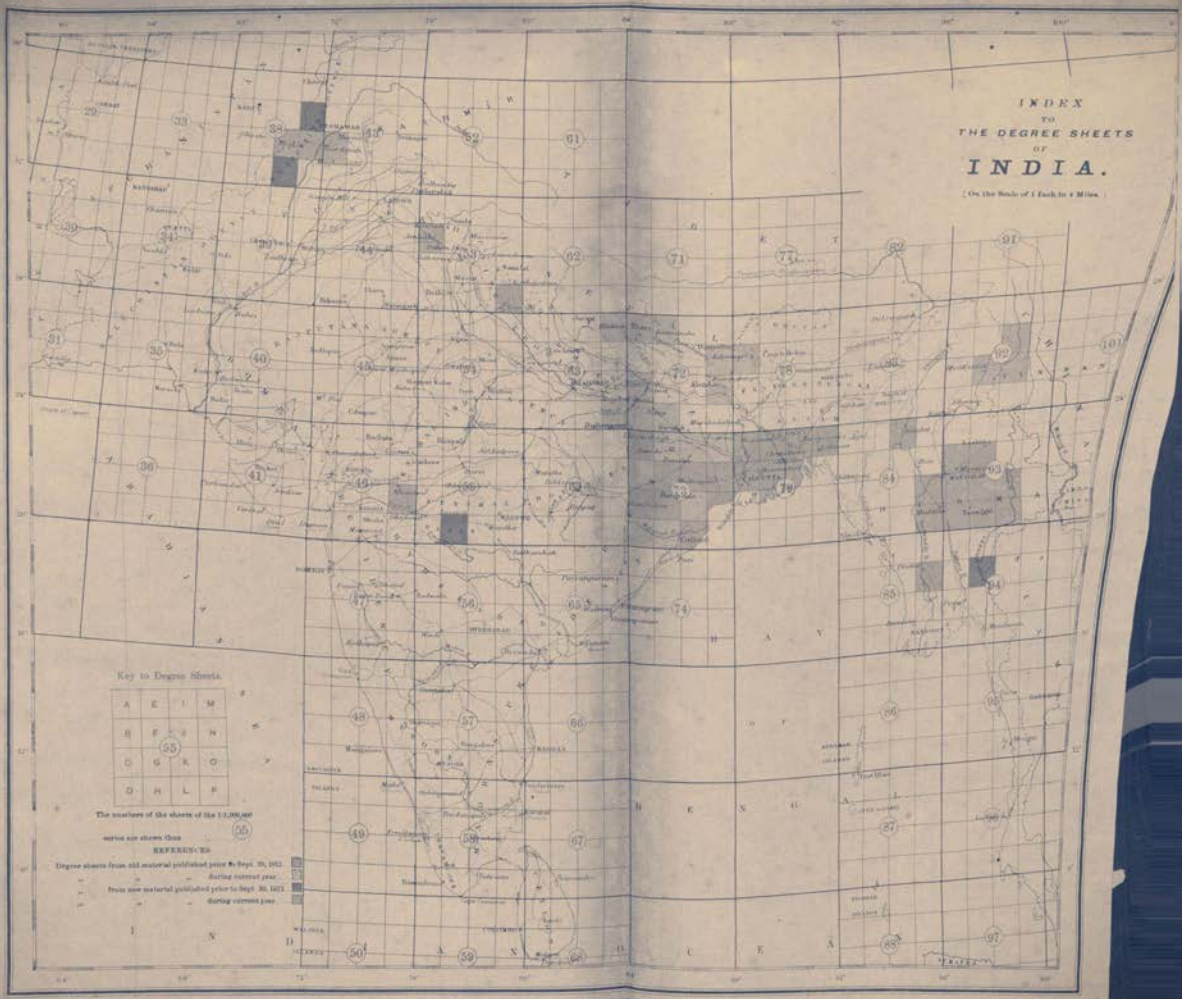
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THE DEGREE SHEETS
OF
INDIA.
(On the Scale of 1 Inch to 4 Miles.)
Key to Degree Sheets.
A E I M
B F J N
D G K O
D H L P
The numbers of the sheets of the 1:1,000,000 series are shown thus
REFERENCES
Degree sheets from old material published prior to Sept. 30, 1912
during current year
from new material published prior to Sept. 30, 1912
during current year
INDIAN OCEAN
BENGAL
HAY
Published under the direction of Colonel N. G. Bannard R.E., F.R.S., Surveying Surveyor-General of India.
1913.

INDEX TO THE SHEETS OF THE

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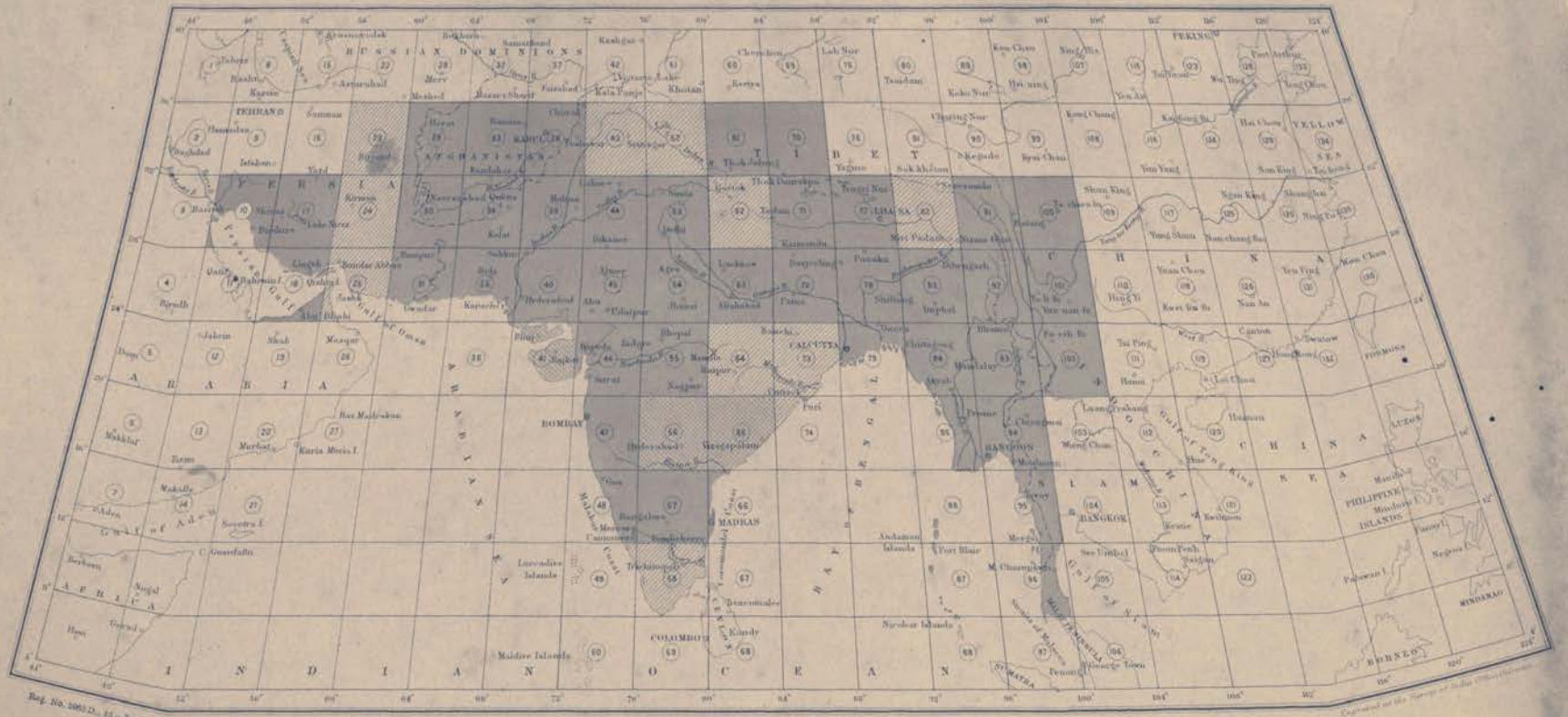

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1910

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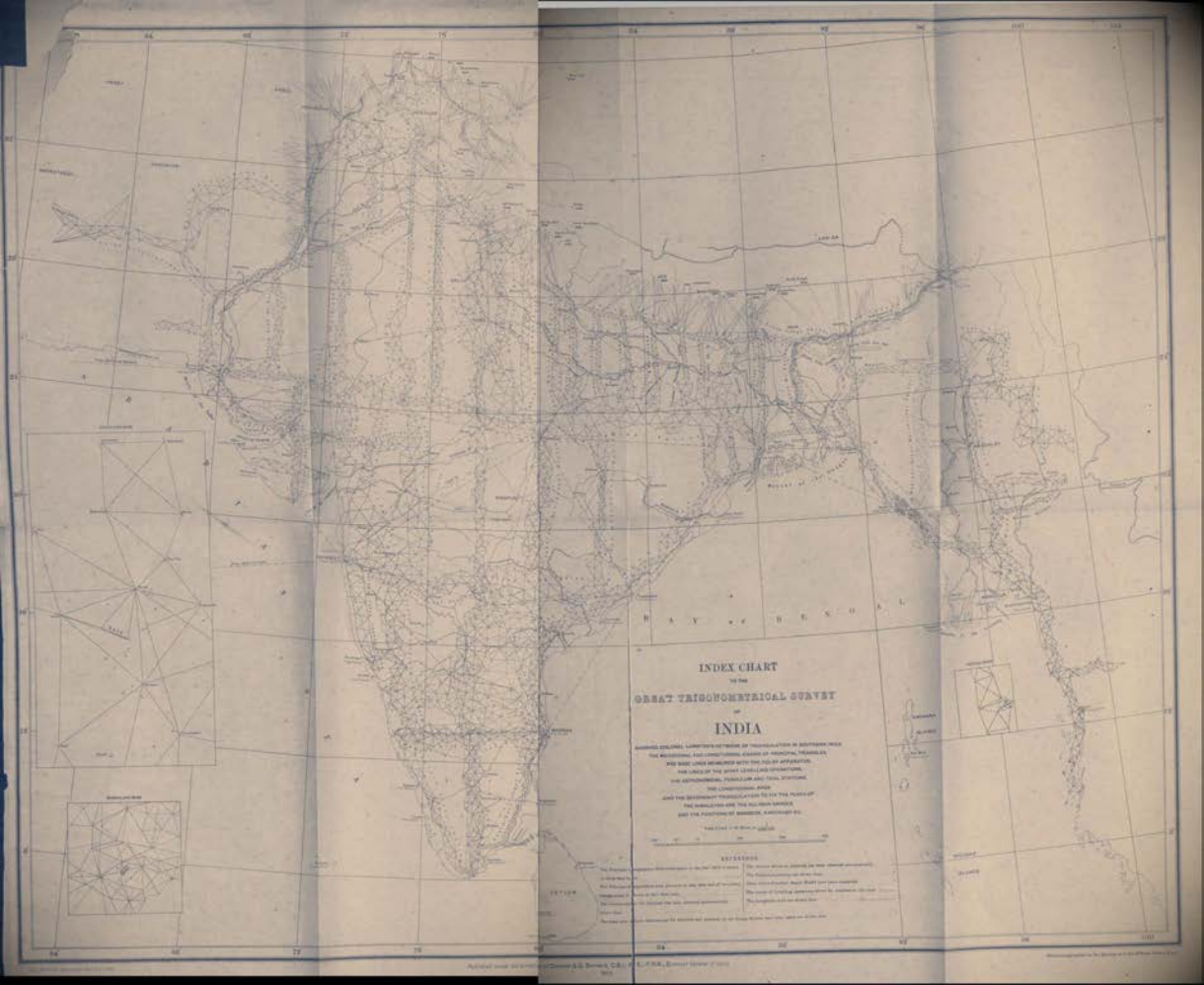
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GREAT TRIGONOMETRICAL SURVEY
OF
INDIA
BAY OF BENGAL

Survey of India.

GENERAL REPORT,

1913-14.

From 1st October 1913

To 30th September 1914.

PREPARED UNDER THE DIRECTION OF

COLONEL SIR S. G. BURRARD, K.C.S.I., R.E., F.R.S.,

SURVEYOR GENERAL OF INDIA.

PRINTED AT THE PHOTO.-LITHO. OFFICE, SURVEY OF INDIA,

CALCUTTA,

1915.

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5. ,, ,, ,, ,, ,, ,, ,, Southern Circle.
6. ,, ,, ,, ,, ,, ,, ,, Eastern Circle.
7. Index to the publication of provisional editions of one-inch sheets, Northern Circle.
8. ,, ,, ,, ,, ,, ,, ,, Eastern Circle.
9. Index to the publication of Degree sheets, scale ½ inch to 1 mile.
10. Index to the publication of sheets of the 'India and Adjacent Countries' Series, scale $\frac{1}{1,000,000}$, or about 16 miles to 1 inch.
11. Index to the publication of Indian sheets of "La Carte Internationale du Monde" on the scale of $\frac{1}{1,000,000}$, or about 16 miles to 1 inch.
12. Index to the publication of sheets of the 'Southern Asia' Series, scale $\frac{1}{2,000,000}$, or about 32 miles to 1 inch.
13. Index to the Great Trigonometrical Survey.

Survey of India.

GENERAL REPORT,

1913-14.

From 1st October 1913
to 30th September 1914.

PART 1.—GENERAL REMARKS.

I.—INTRODUCTION.

1. The main parts of this report, as shewn in the "Contents" on the opposite page, are *Part 2—Field Work*, summarising the operations of the field parties, grouped under appropriate headings; and *Part 3—Office Work*, which gives a brief account of the year's progress in the head-quarters and other offices. Fuller details of these operations are being published in Volume VII of the "Records of the Survey of India".

2. An abstract showing the progress of the topographical programme assigned to the department in 1905, may be found in Table II on page 7. From this it will be seen that the out-turn of new topographical survey during the current year was 54,359 square miles; and that this brings the total progress since 1905 to about 3,66,000 square miles, leaving about 14,55,000 square miles still to be done.

3. The first eight Index maps, at the end of the report, show the progress of this topographical programme. Two indexes for each circle give respectively the progress in survey and in publication; and a third index shows, in the case of the Northern and Eastern Circles, the publication of provisional issues of 1-inch maps compiled from miscellaneous materials.

4. The remaining 5 indexes at the end show progress of the smaller scale maps appertaining to the scheme, and also the main framework of triangulation on which the Survey of India is based.

5. Table IV on page 32 gives a list of the new publications of the Calcutta Offices during the year. A complete list of departmental publications, apart from maps, may be found in the Annual "Records Volume"; and lists of new maps are published quarterly by the department, as well as in the monthly "Notes of the Survey of India".

6. Progress in the Trigonometrical Branch can only be assessed by a study of the "Records Volume" and the special publications issued at Dehra Dūn. The General Report can attempt little more than a brief abstract of the *locale* and nature of the different operations.

7. Notable events of the Survey year were as follows:—

(a) The return of Captains Bailey and Morshead from six months *exploration in the Eastern Himālayas.* This has added greatly to our geographical knowledge of these regions, besides clearing up all doubts as to the course of the Tsan-po or Brahmaputra river.

(b) A report on the *Magnetic Survey of India* was prepared by a special committee appointed by the Government of India for the purpose.

(c) New possibilities of scientific exploration have been opened up by the successful experiment of observing accurate differential *longitudes by wireless telegraphy* across the highest mountain ranges. This was effected by Cavaliere de Filippi's Italian expedition, in co-operation with our observatory at Dehra Dūn and the Lahore Radio Office.

(d) The department has now issued its first attempts at producing large *Orographical maps* on the system of coloured layers. These maps give a clearer idea of the main physical features of India and Adjacent Countries than the older maps did; and it is hoped that the experience gained in these first efforts, and the various criticisms they have elicited, may result in the further improvement of this difficult branch of Cartography.

(e) A commencement has been made in the new system of *keeping Cantonment maps up-to-date,* at the Dehra Dūn Office, by means of information to be supplied annually by the officers of the Military Works Services.

(f) Two Imperial Officers were deputed to work with the *Turco-Persian Frontier Commission,* and one to co-operate with *Cavaliere de Filippi's expedition* to the Karakoram.

(g) The department has completed a framework of high accuracy for the *Bombay City Survey,* and has lent two Provincial Officers to the Bombay Government to conduct the detail survey.

(h) The proposal to introduce the scale of $\frac{1}{2}$ inch to 1 mile for the tactical map of India has received strong support.

II.—ADMINISTRATION AND PERSONNEL.

8. The cost of the department for the financial year ending 31st March 1914 was Rs. 35,74,411, against an estimated cost of Rs. 36,23,910.

9. Colonel Sir Sidney G. Burrard, K.C.S.I., R.E., F.R.S., administered the department during the greater part of the year under report, having resumed charge on his return from leave, on the 15th December 1913, from Colonel T. F. B. Renny-Tailyour, C.S.I., R.E., who was Officiating Surveyor General of India up to that date.

10. Colonel G. B. Hodgson, I.A., Superintendent, retired on the 28th October. Lieutenant F. P. Nosworthy, R.E., was appointed to the department from the 1st November 1913, and Lieutenant L. H. Jackson, I.A., from the 7th September 1914.

There were six losses to the Provincial Service, by the death of Messrs. C. Litchfield and H. D. W. Stotesbury, and by the retirement of Messrs. P. L. Causley, Amjad Ali and Balaji Dhondiba Mandhre, and by the transfer of Mr. H. St. J. Kenny to the Federated Malay States. No Provincial Officers were recruited during the year.

11. The following honours were conferred on members of the department during the year :—

To be K.C.S.I.— Colonel S. G. Burrard, C.S.I., R.E., F.R.S., Surveyor General.

To be C.I.E.— G. B. Scott, Esq., (retired), Survey of India.

Title of Rai Bahadur.—Rai Sahib Chuni Lal Dey, Registrar.

Title of Rai Sahib.—Mr. Narendra Nath Mukerji, Head Accountant.
Mr. Hira Singh, Assistant S. T. S. Office.

12. The total strength of the department at the close of the Survey year was 50 Imperial Officers, 125 Provincial Officers and 31 Upper Subordinates, besides specialists, clerks, lower subordinates, and menials.

13. The following table shows the distribution of officers during the year, excluding those absent on leave throughout the year, or on deputation with local Governments. It will be noticed that several names occur more than once in the list, through the transfer of officers from one office to another. A few very temporary transfers in September, arising from changes due to the war, have been omitted.

TABLE 1—DISPOSITION OF OFFICERS, 1913-14.

SURVEYOR GENERAL OF INDIA— { Colonel Sir Sidney G. Burrard, K.C.S.I., R.E., F.R.S., from 15th Dec. 1913.
{ Colonel T. F. B. Renny-Tailyour, C.S.I., R.E., officiating to 14th Dec. 1913.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Surveyor General's Office and Mathematical Instrument Office,* Calcutta.	Captain J. A. Field, R.E.			
No. 6 Drawing Office, Simla.	Major H. H. Turner, R.E. Captain M. N. MacLeod, R.E.	Mr. A. A. Graham ,, F. C. Saint ,, W. H. Strong		†6 European Draftsmen. 24 Indian Draftsmen and Clerks. 4 Printers.
Turko-Persian Frontier Detachment.	Lieut.-Colonel C. H. D. Ryder, D.S.O., R.E. Major H. M. Cowie, R.E.	,, Haji Abdul Rahim, K.B.	Mr. Sher Jang, K.B.	Two Surveyors, &c.

SUPERINTENDENT MAP PUBLICATION—Major W. M. Coldstream, R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Map Publication Office, Calcutta.		Mr. M. Gastaud		
No. 1 Drawing Office, Map Record and Issue Office and Engraving Office, Calcutta.	Major M. O'C. Tandy, R.E. Captain F. F. Hunter, I.A. Captain H. J. Couchman, R.E.	,, C. Litchfield ,, J. O. Greiff ,, T. W. Babonau ,, P. Williams ,, Jagdamba Prasad ,, C. C. Byrne ,, P. L. Causley, Retired from January 20th, 1914. ,, A. B. Hunter ,, P. Simpson ,, P. N. Sur ,, E. J. R. Hanby ,, F. E. R. Calvert		
Photo.-Litho. Office, Calcutta.	Capt. S. W. S. Hamilton, R.E.			
Mathematical Instrument Office, Calcutta.	Captain J. A. Field, R.E. Mr. T. A. Ferrier			

* The Mathematical Instrument Office was transferred to the control of the Superintendent Map Publication from the 1st September 1914.

† Includes Army Section under Major C. J. Arbery.

TABLE I—(Continued).—DISPOSITION OF OFFICERS, 1913-14.

SUPERINTENDENT NORTHERN CIRCLE—{Colonel W. J. Bythell, R.E.,—6th October 1913 to 30th Sept. 1914. {Lieut.-Colonel C. L. Robertson, C.M.G., R.E.,—1st to 5th Oct. 1913.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 3 Drawing Office, Mussoorie.		Mr. C. Litchfield (Died 1st September 1914) „ H. W. Biggie „ J. A. Freeman „ M. C. Petters „ B. M. Berrill		45 Clerks, Surveyors and Draftsmen, &c.
No. 1 Party, *Kashmir, Punjab and N.-W. F. Province.*	Major A. A. McHarg, R.E. Major M. O'C. Tandy, R.E. Lieutenant H. M. McKay, R.E.	Mr. H. H. B. Hanby „ F. A. T. Kenny „ R. B. West „ D. K. Remick „ R. C. Hanson „ H. T. Hughes „ W. J. B. Miller	Mr. Sher Jang, K.B. „ Natha Singh, R.S. „ Paras Ram „ Janna Prasad	34 Surveyors, &c.
No. 2 Party, *Punjab.*	Captain G. F. T. Oakes, R.E. Captain F. B. Scott, I.A.	Mr. R. B. Hughes „ T. W. Raboman „ F. B. Powell „ Kanak Singh „ R. E. Saulodle „ E. C. O'Sullivan „ J. H. Johnson „ F. W. Smith „ J. A. Calvert		41 Surveyors, &c.
No. 3 Party, *Punjab and United Provinces.*	Captain F. F. Hunter, I.A. Captain F. B. Scott, I.A.	Mr. J. O. Greiff „ J. A. Freeman „ E. J. Biggie „ A. C. Bose „ F. A. T. Kenny „ A. J. A. Decke „ F. H. Grant „ H. T. Hughes „ F. J. Grice „ Moqimuddin	Mr. Mahomed Lutf Ali „ Mahindar Singh „ Muhammad Husain	63 Surveyors, &c.
No. 4 Party, *United Provinces.*	Captain L. C. Thuillier, I.A. Captain R. Foster, I.A.	Mr. H. W. Biggie „ G. J. S. Rae „ J. C. C. Lears „ G. E. R. Cooper „ Duni Chand Puri	Mr. Mohammad Husain Khan	46 Surveyors, &c.
No. 20 Party, *Guna, Kamptee, Rajkot and Sitabaldi Fort.*		Mr. A. Ewing „ C. S. Littlewood	Mr. Dharmar	24 Surveyors, &c.
Riverain Detachment, *Punjab.*		Mr. Maya Das Puri, R.S.	Mr. Chuni Lal Kapur „ Mahindar Singh	79 Surveyors, &c. 12 Naib Tahsildars, Kanungos, &c.
Simla Survey Detachment, *Simla.*		Mr. C. E. C. French	Mr. Paras Ram	14 Surveyors, &c.

SUPERINTENDENT SOUTHERN CIRCLE—{Colonel T. F. B. Remy-Tailyour, C.S.I., R.E., 8th to 30th September 1914. {Lieut-Colonel F. W. Pirrie, I.A., up to 7th September 1914.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 4 Drawing Office, Bangalore.		Mr. J. H. Nichol „ F. P. Walsh	Mr. B. V. Narayana Rao	36 Draftsmen, &c.
Training Section, Bangalore.		Mr. W. M. Gorman	Mr. H. Narasimhamurti Rao	1 Surveyor and 13 Pupils.
No. 5 Party, *Central Provinces and Berar.*	Captain E. C. Baker, R.E. Lieutenant R. S. Walsh, I.A. Lieutenant R. L. Almond, R.E.	Mr. J. H. S. Wilson „ S. S. McA'Fee Fielding „ F. C. Pilcher „ Munshi Lal, B.A. „ C. O. Picard „ A. V. Dickson	Mr. Eknath Ratfu „ Ram Narayan Hastir	27 Surveyors, &c.
No. 6 Party, *Berar and Hyderabad.*	Major H. Wood, R.E. Captain K. W. Pye, R.E. Lieutenant C. G. Lewis, R.E.	Mr. E. A. Meyer „ Haji Abdul Rahim, K.B. „ F. B. Kitchen „ R. B. Gibles „ K. S. Gopalachari B.A. „ J. O'C Fitzpatrick „ A. J. Moore	Mr. Damodar Kadilkar	32 Surveyors, &c.
No. 7 Party, *Madras and Mysore.*	Lieut.-Col. F. W. Pirrie, I.A. Captain J. D. Campbell, R.E.	Mr. J. O'B. Donaghey „ P. R. Anderson „ C. West „ H. D. W. Stotesbury (Died 30th October 1913) „ Haji Abdul Rahim, K.B. „ H. R. P. Butterfield „ J. C. St. C. Pollett	Mr. Abdul Hakk, K.S. „ Kodandera Mandanna	28 Surveyors, &c.
No. 8 Party, *Madras.*	Capt. C. M. Browne, D.S.O., R.E.	Mr. W. F. E. Adams „ S. F. Norman „ J. H. Williams „ F. Kemezy „ M. Mahadeva Mudaliar, B.A.	Mr. Anantarao Dhondiba Mandhre, R.S. „ K. Narayanaswami Chetti „ P. S. Venguswami	36 Surveyors, &c.

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1913-14.

SUPERINTENDENT EASTERN CIRCLE— Lieut.-Colonel C. H. D. Ryder, D.S.O., R.E., till 7th November 1913. Major A. Mears, I.A. 8th to 28th November 1913. Lieut.-Colonel G. L. Robertson, C.M.G., R.E., from 29th November 1913.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 5 Drawing Office, Shillong.	Lieut. P. G. Huddleston, R.E.	Mr. P. J. Barrington ,, J. P. Barker		35 Surveyors, Draftsmen, &c.
No. 9 Party, *Bihar and Orissa.*	Captain R. H. Phillimore, R.E. ,, E. B. Cardew, R.E.	Mr. Dhani Ram Verma ,, B. C. Newland ,, L. B. Fitz-Gibbon ,, A. K. Mitra ,, W. P. Hales ,, V. P. Wainright ,, D. N. Banerjee, B.A.	Mr. Balbir Rai ,, Ram Singh.	37 Surveyors, &c.
No. 10 Party, *Upper Burma.*	Major E. T. Rich, R.E. Captain L. G. Crosthwait, I.A. Lieut. W. E. Perry, R.E. ,, H. E. Roome, R.E.	Mr. J. Smith ,, W. G. Jarbo ,, H. R. Simons ,, V. W. Morton ,, Asmat-Ullah Khan, K.S. ,, C. B. Sexton ,, A. F. Murphy	Mr. Lachman Daji Jadu, R.E. ,, Hayat Muhammad, K.S. ,, Maung Kyaw Nyein	33 Surveyors, Draftsmen, &c., 6 Pupils.
No. 11 Party, *Lower Burma.*	Captain L. G. Crosthwait, I.A. Lieut. F. J. M. King, R.E.	Mr. A. M. Talati ,, T. P. Dewar ,, F. E. R. Calvert ,, A. J. Booth ,, R. M. Wyatt	Mr. Raghubar Datt Thapliyal	29 Surveyors, &c.
No. 12 Party, *Assam.*	Major A. Mears, I.A. Lieut. P. G. Huddleston, R.E.	Mr. W. Skilling ,, Pramadaranjan Ray, R.S. ,, E. Claudius ,, E. M. Kenny ,, Amjad Ali, Retired April 22nd 1914 ,, L. Williams ,, P. C. Mitra, B. A. ,, H. H. Creed	Mr. Nanak Chand Puri, B.A. ,, Sajani Kumar Ghosal	34 Surveyors, &c., 6 Pupils, 4 Soldier Surveyors.
Aka Promenade Detachment.	Lieut. P. G. Huddleston, R.E.			1 Surveyor.
Andamans Detachment.		Mr. E. Claudius		8 Surveyors.

SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY— Lieut.-Colonel G. P. Lenox-Conyngham, R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates &c.*
Trigonometrical Survey Office, Dehra Dun.	Mr. J. deGraaff Hunter, M.A.	Mr. H. A. Charrier ,, Hamman Prasad	Mr. Sarat Kumar Mukerji	
Training School	Lieut. A. A. Chase, R.E.		Mr. Satish Chandra Mukharji	
Under training.	,, W. E. Perry, R.E. ,, F. T. Nosworthy, R.E.		,, Lakshmi Dutt Joshi ,, Vidya Dhar Chopra ,, Mirza Muhammad Ahsan ,, Lachman Das Sood	*Under training.* Resigned 16th May 1914.
No. 2 Drawing Office and Forest Map Office, Dehra Dun.	Major H. H. Turner, R.E. ,, G. A. Beazeley, R.E.	Mr. O. C. Ollenbach ,, E. C. J. Bond ,, H. C. W. Stotesbury ,, O. N. Pushong ,, Abdul Karim	Mr. Ram Singh, R.S.	
No. 13 Party, *(Latitudes).*	Captain V. R. Cotter, I.A.			3 Computers, &c.
No. 14 Party, *(Pendulums).*	Captain H. J. Couchman, R.E. ,, G. F. T. Oakes, R.E.	Mr. O. N. Pushong ,, C. S. McInnes		4 Computers, &c.
No. 15 Party, *(Triangulation).*	Major G. A. Beazeley, R.E. ,, E. A. Tandy, R.E. ,, H. M. Cowie, R.E. Lieut. K. Mason, R.E.	Mr. C. H. Tevshaw ,, V. D. B. Collins ,, V. P. Wainright ,, L. Williams ,, G. A. Norman ,, B. T. Wyatt ,, C. S. McInnes ,, Abdul Karim ,, K. S. Gopalachari ,, A. J. Moore ,, N. S. Hariharan Iyer	Mr. Jugal Behari Lal	24 Computers, &c.
No. 16 Party, *(Tidal).*		Mr. Syed Aulad Hossein, C.I.E. Mr. Syed Zille Hasnain		20 Computers, &c.
No. 17 Party, *(Levelling).*		Mr. H. G. Shaw ,, D. H. Lucas ,, J. McCracken ,, T. F. Kitchen ,, M. S. Ganesa Aiyar ,, O. D. Jackson ,, Jiya Lal ,, N. N. Chuckerbutty	Mr. Karuna Kumar Das, B.A.	12 Computers, &c.
No. 18 Party, *(Magnetic).*	Captain R. H. Thomas, R.E. Lieutenant K. Mason, R.E.	Mr. H. P. D. Morton ,, Rama Prasad Ray, B.A. ,, N. R. Mazumdar ,, Raj Bahadur Mathur, B.A.	Mr. Bidhu Bhusan Shome	18 Recorders, &c.
No. 19 Party, *(Base Line).*	Major E. A. Tandy, R.E. Lieut. A. A. Chase, R.E.			3 Computers, &c.
Exploration *In Chinese Turkistan with Count Filippo de Filippi.*	Major H. Wood, R.E.		Mr. Jamna Prasad	1 Surveyor.
Tibet *In Central Asia with Sir Aurel Stein*	Captain H. T. Morshead, R.E.		Mr. Lal Singh, R.S.	1 Surveyor.

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PART 2.—FIELD WORK.

I.—TOPOGRAPHICAL SURVEYS.

4. **The two following tables** show respectively the progress of the topographical programme assigned to the department in 1905, and the out-turns and costs of different parties during the year under report. They are followed by brief descriptions of the work of each topographical party.

Table II.—Progress of Topographical Surveys since 1905.

Survey year.	Scales of Survey.	Northern Circle.	Southern Circle.	Eastern Circle.	TOTALS.
		Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-06 ...	Mostly 2-inch and 1-inch	5,995	1,660	10,322	17,977
1906-07 ...	ditto ...	7,277	7,666	8,659	23,602
1907-08 ...	ditto ...	14,530	9,256	12,431	36,217
1908-09 ...	ditto ...	17,957	12,526	11,542	42,025
1909-10 ...	Mostly 1-inch ...	23,833	12,532	9,736	46,101
1910-11 ...	ditto ...	27,528	13,171	9,218	49,917
1911-12 ...	ditto ...	23,852	9,115	10,654	43,621
1912-13 ...	Mostly 1-inch and ½-inch	27,240	13,349	11,836	52,425
1913-14 ...	ditto ...	**23,625**	**15,844**	**14,890**	**54,359**
Total Areas completed to date ...		**1,71,837**	**95,119**	**99,288**	**3,66,244**
Approximate areas for the whole topographical programme.		**7,50,000**	**5,42,800**	**5,28,800**	**18,21,600**
Approximate areas remaining for survey.		**5,78,163**	**4,47,681**	**4,29,512**	**14,55,356**

Table III.—OUT-TURNS and COSTS of Topographical Surveys, 1913-14.

PARTY and LOCALITY. Character of ground.	Scale and type of Survey.	OUT-TURNS. Areas of Survey.	OUT-TURNS. Totals on all Scales.	TOTAL COSTS. Survey and Mapping.	Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Cost-rates. Rs.*	**NORTHERN CIRCLE.**
No. 1 Party—*Kashmir, Punjab, and N.-W. F. Province.*						
Open plains and wooded hills	1-inch Survey	2,652				
Jammu town and environs	2-inch Survey	33				
Mountainous and fairly wooded	½-inch Revision Survey ...	125		1,10,403*		* Excludes *Rs.* 281, cost of work on field litho.-press.
Ditto ditto	½-inch Revision Survey ...	869	3,679		30·0	
No. 2 Party—*Punjab.*						
Plains, partly open, partly irrigated	1-inch Revision Survey ...	5,190		1,08,122		
Ditto ditto	1-inch Resurvey	1,514	6,704		16·1	
No. 3 Party—*Punjab and United Provinces.*						
Himalayan foot-hills and plains	1-inch Revision Survey ...	6,118		1,13,222		
Ditto ditto	1-inch Resurvey	84	6,202		18·3	
No. 4 Party—*United Provinces and Nepal.*						
Himalayan foot-hills and plains	1-inch Resurvey	4,726		97,637		
Ditto ditto	1-inch Supplementary Survey	2,314	7,040		13·9	
TOTALS, NORTHERN CIRCLE:—		**23,625 sq. m.**		**Rs. 4,29,384**		**Cost-rate 18·2**
		Sq. miles.		*Rs.*	*Cost-rates. Rs.*	**SOUTHERN CIRCLE.**
No. 5 Party—*Central Provinces and Berar.*						
Varied, jungle-covered hills, undulating plateau and open plains.	1-inch Survey	3,505		1,14,763		
	1-inch Revision Survey ...	637	4,142		27·7	
No. 6 Party—*Berar and Hyderabad.*						
Open plains, undulating, and hills	½-inch Survey	3,086				
Open undulating plains	1-inch Survey	2,268		89,513		
Intricate ground, with thin forest	2-inch Survey	171	5,525		16·2	
No. 7 Party—*Madras and Mysore.*						
Low forest-clad or rocky hills and open cultivated plains.	1-inch Survey	3,041				
	2-inch Survey	177		99,178		
Forest-clad hills	1-inch Supplementary Survey ...	1,393	4,611		21·5	
No. 8 Party—*Madras.*						
Forest-clad hills, inhabited valleys	1-inch Survey	1,223		1,27,462		
Flat enclosed coast country	1½-inch Survey	343	1,566		81·4	Very difficult country.
TOTALS, SOUTHERN CIRCLE:—		**15,844 sq. m.**		**Rs. 4,30,916**		**Cost-rate 27·2**
		Sq. miles.		*Rs.*	*Cost-rates. Rs.*	**EASTERN CIRCLE.**
No. 9 Party—*Bihar and Orissa.*						
Undulating and wooded	1-inch Survey	560				
Undulating and open	1-inch Supplementary Survey ...	2,114				
Undulating forest ...	2-inch Survey	11		1,04,649		
Undulating and wooded	½-inch Revision Survey ...	1,695	4,380		23·9	
No. 10 Party—*Upper Burma.*						
Mostly hilly and thickly wooded	1-inch Survey	4,024				
Ditto ditto	1-inch Revision Survey ...	587				
Ditto ditto	1-inch Reconnaissance Survey	60 *(a)*		1,77,423 *(b)*		*(a)* Trans-border, not included in total.
Ditto ditto	2-inch Survey	92	4,703		37·7	*(b)* Excludes Rs. 42,592, for forest boundary surveys and Maymyo Drawing Office.
No. 11 Party—*Lower Burma.*						
Mostly hilly and densely wooded	1-inch Survey	2,437				
Ditto ditto	1-inch Revision Survey ...	62		1,45,896 *(c)*		*(c)* Excludes Rs. 3,506, for forest boundary survey-41.
Ditto ditto	2-inch Survey	95	2,594		56·3	*(d)* Includes 20 sq. miles special forest survey.
No. 12 Party—*Assam.*						*(e)* Includes Rs. 17,516, for special forest survey, debitable to Forest Department.
Partly open plains and grass jungle, partly densely wooded hills.	1 inch Survey	1,421				*(f)* Excluding cost of mapping, to be done by Forest Map Office.
	1-inch Revision Survey ...	66				
	1-inch Supplementary Survey ...	1,348 *(d)*				
	2-inch Survey	54		1,36,548 *(e)*		
	4-inch Special Forest Survey ...	22	2,911		46·9	
Andamans Detachment—*Andaman Islands.*						
Densely wooded hills and mangrove swamps.	2-inch Skeleton Survey (uncontoured.)	302	302	23,692 *(f)*	78·5	
TOTALS, EASTERN CIRCLE:—		**14,890 sq. m.**		**Rs. 5,88,208**		**Cost-rate 39·5**
GRAND TOTALS:—		**54,359 sq. m.**		**Rs. 14,48,508**		**Cost-rate 26·6**

NORTHERN CIRCLE (*vide* index map No. 1).

15. No. 1 Party.—This Party surveyed a total area of 2,652 square miles in S. Waziristān and Dera Ismail Khān district of the N.-W. Frontier Province, Riāsi, Mīrpur, Udhampur, Jammu and Jasrota districts and Pūnch State, in Kashmīr and Jammu State, and Siālkot district in the Punjab, on the 1-inch scale. An area of 33 square miles, comprising Jammu town and the intricate country in its vicinity, was surveyed on the 2-inch scale. In addition, revision work was carried on in Ladākh district, 125 square miles on the half-inch, and 869 square miles on the quarter-inch being returned.

16. No. 2 Party.—This Party surveyed a total area of 6,704 square miles on the 1-inch scale in the districts of Gujrāt, Gujrānwāla, Siālkot, Lahore, Hissār, Karnāl, and Rohtak, and in the Phūlkiān States of Patiāla and Jīnd, all in the Punjab. The country surveyed was flat, canal irrigated and well cultivated.

In addition, triangulation and traversing of 2,280 square miles and 738 linear miles respectively, were carried out for future 1-inch detail survey in parts of the district of Gurgaon and in the Phūlkiān States of Patiāla, Nābha, Jīnd and in Alwar and Lohāru States.

The field headquarters of the Party was transferred from Ferozepore to Hissār.

17. No. 3 Party.—This Party surveyed a total area of 6,202 square miles of which 6,118 square miles were 1-inch revision survey and 84 square miles resurvey. The 1-inch resurvey comprised a small part of Tehrī State bordering upon Dehra Dūn, while the revision comprised, in the Punjab, parts of the districts of Simla, Ambāla, Karnāl, and Rohtak, with parts of the following Simla Hill States:—Bhajji, Dhāmi, Keonthal, Koti, Bāghal, Baghāt, Nālāgarh, Kuthār, Bijā, Mailog and Kunihār, also parts of Suket, Sirmūr and Patiāla States; and in the United Provinces, parts of the districts of Dehra Dūn, Sahāranpur, Muzaffarnagar, Meerut and Garhwāl and parts of Tehrī State.

The area surveyed consisted of the well cultivated and irrigated plains of the United Provinces and Punjab, parts of the intricate forest clad Siwālik Range, and portions of the outer Himālayas with a fringe of the sub-Himālayas. The principal rivers traversing the area surveyed are the Sutlej and Giri on the north, the Jumna on the west, and Ganges on the east.

The old 1-inch sheets were adjusted to plotted traverse data and the detail transferred to the plane-tables. In Dehra Dūn and the Siwālik Hills the old sheets were found to be inaccurate, but in the remainder of the area, except along the banks of rivers, water-courses and canals, they were of great assistance.

18. No. 4 Party.—This Party surveyed an area of 7,040 square miles consisting of 4,726 square miles new survey and 2,314 square miles supplementary survey, all on the 1-inch scale in the districts of Shāhjahānpur, Hardoī, Kherī, Gondā, Bahraich, Bastī and Fyzābād of the United Provinces and Nepāl. The greater portion of the country consisted of highly cultivated plains covered with orchards; on the north, where the districts border on Nepāl, lies a fringe of dense jungle. The part of Nepāl surveyed north of Kherī and Bahraich districts, consisted of plains covered with dense jungle interspersed with patches of cultivation and intersected by numerous streams; that to the north of Gondā and Bastī was steep hills rising to 3,000 feet, and covered in many places by thick jungle.

19. The work of the following parties, also belonging to this circle, is reported on pages 14 to 16. *No. 20 Party (Cantonment)—Punjab Riverain detachment-and Simla Survey detachment.*

SOUTHERN CIRCLE (*vide* index map No. 2).

20. No. 5 Party.—No. 5 Party surveyed an area of 4,142 square miles in the Hoshangābād, Narsinghpur, Chhindwāra, Betūl, Nāgpur and Wardhā districts of the Central Provinces and in the Amraoti district of Berār, and triangulated an area of 5,796 square miles in the Betūl and Nimār districts of the Central Provinces and in the Amraoti and Akola districts of Berār. The nature of the country surveyed varied, it included the steep and wooded hills on the north of the Sātpurā plateau, the undulating and comparatively open plateau, the steep wooded drop off the south edge of the plateau and the flat or undulating cultivated plains below.

2 . No. 6 Party.—No. 6 Party surveyed an area of 5,525 square miles in the Akola and Buldāna districts of Berār and in the Nānder and Parbhani districts of Hyderābād, and triangulated an area of 8,985 square miles in the Aurangābād, Bhīr, Parbhani and Osmānābād districts of Hyderābād and in the Ahmadnagar district of Bombay. The country was of a varied nature, parts of the northern area were intricate and similar to that surveyed in previous years, while towards the south and west it became more open and easy to survey. More than half the area under survey lay in Hyderābād and was surveyed on the $\frac{1}{2}$-inch scale. This has resulted in a considerable increase in out-turn and a further increase is anticipated.

22. No. 7 Party.—No. 7 Party surveyed an area of 4,611 square miles, in the Salem, North Arcot, South Arcot and Chittoor districts of Madras and in the Kolār district of Mysore; and triangulated 5,226 square miles in the North Arcot, South Arcot, Chingleput and Chittoor districts of Madras and in French territory near Pondicherry. The country surveyed was very varied in character, it consisted of forest clad hills, lower rocky hills covered with scrub or almost devoid of vegetation and open cultivated plains.

23. No. 8 Party.—No. 8 Party Surveyed an area of 1,566 square miles in the Travancore State of Madras, triangulated 1,005 square miles in the Coimbatore, Madura, and Tinnevelly districts and in the Travancore State of Madras, and traversed 55 linear miles in the Travancore State of Madras. The country surveyed was very varied in character, ranging from the densely inhabited country on the coast to the unexplored portions of the Pandalam hills. The only knowledge of the latter was a note left by Lieutenants Ward and Connor many years ago, in which they said "the country consisted of high rugged mountains covered with a dark impenetrable forest wherein dwelt divers wild beasts". The survey was difficult and entailed considerable hardships on the members of the party.

EASTERN CIRCLE (*vide* index map No. 3).

24. No. 9 Party.—No. 9 Party surveyed an area of 4,380 square miles. Of the total area 2,674 square miles were surveyed on the 1-inch scale in Hazāribāgh and Rānchī districts and Jashpur State, 1,695 square miles on the ½-inch scale in Gāngpur and Bāmra States and 11 square miles of forest survey was made on the 2-inch scale. The country surveyed in Rānchī and Jashpur mostly consists of numerous small plateaus falling away to the south to a series of undulating terraces separated by rugged scarps. In Gāngpur State the country is undulating and wooded, with rocky hill ranges. Triangulation was carried out over parts of the Santāl Parganas, about 3,432 square miles being covered; theodolite traverses were also made, amounting to 245 linear miles, for controlling future topographical work in Birbhūm and Murshidābād districts, and 108 linear miles of forest boundary survey in the Santāl Parganas and Hāzāribāgh.

25. No. 10 Party.—No. 10 Party surveyed in detail an area of 4,763 square miles, in the Kathā, Myitkyinā and Mandalay districts of Upper Burma, including 679 square miles of country beyond the Burma-China Frontier and in unadministered territory, of which 60 square miles were sketched. 6,150 square miles were triangulated in the Myitkyinā district, and 330 linear miles of forest boundary surveys were completed. The country surveyed varied from the low lying Kaukkwe valley in the Kathā district, which was less than 500 feet above sea level, to the high hills along the Burma-China Frontier, some of which were over 13,000 feet high and covered with snow during the winter months. Both plains and hills were thickly wooded, and it was difficult to obtain views of the surrounding country, except where ground had been cleared for cultivation.

26. No. 11 Party.—No. 11 Party surveyed an area of 2,594 square miles on the 1-inch and 2-inch scales in the Tavoy district of the Tenasserim division of Lower Burma, and triangulated 2,200 square miles in the Mergui district; 66·4 linear miles of theodolite traverse for forest boundary surveys were completed. The country was similar to that surveyed the previous year, but even less accessible. The area between the Siam Frontier and the main range, dividing the Tenasserim river drainage from the seaboard, consisted of steep densely wooded hills rising to nearly 7,000 feet with few inhabitants or communications, while the country along the sea coast was more open.

The area surveyed also included the South Mescos Islands.

27. No. 12 Party.—No. 12 Party surveyed an area of 2,911 square miles on all scales in the Darrang, Nowgong, Sibsāgar and Lakhimpur districts of Assam, and carried out 473 linear miles of traversing. The above area includes 54 square miles of reserved forests surveyed on the 2-inch scale, and 22 square miles of special 4-inch forest survey.

The country under survey consisted mainly of the plains of the Brahmaputra valley, which, where not under tea and other cultivation, are covered with trees and high grass, interspersed with numerous swamps and, "bils"; the remainder of the area comprised densely wooded hills rising to an elevation of about 4,000 feet.

One surveyor was attached for about a couple of months to the Akā Promenade Survey Detachment.

II.—FOREST SURVEYS.

28. During the year 1913-14, the forest surveys have, as usual, been carried out by the topographical parties of the Survey of India. In the majority of cases the surveys were executed on the scale of two inches to the mile, but in some few instances the work was done on the one-inch scale. A considerable extent of forest boundaries was also surveyed on the scale of four inches to the mile. The revision of certain areas previously surveyed on the four-inch scale by the old Forest Survey Branch was also effected.

NORTHERN CIRCLE.

29. No forest surveys were carried out in this circle during the year under report.

SOUTHERN CIRCLE.

30. Central Provinces. (Berār Circle).—Forest surveys on the scale of two-inches to the mile and plane-table boundary traverses on the scale of four-inches to the mile were continued by No. 6 Party in Berār.

In the Akola division, the Loni and Mohoja reserves were surveyed; and in the Buldāna division, the Gerumātergaon, Amdari, and other small reserves of the A, B and C classes were completed. The area surveyed on the two-inch scale amounted to 145·9 square miles and the four-inch plane-table boundary surveys to 397·9 linear miles.

31. Madras Presidency.—In the course of its ordinary operations, No. 7 Party surveyed on the two-inch scale, 6 reserved forests in the Salem district, and 16 in the North and South Arcot districts. The area of the former is 23·7 square miles and of the latter 146·3 and 6·9 square miles respectively. No new theodolite boundary traverses were executed, but the boundaries were checked as far as possible with the 8-inch Madras Revenue traverse maps in the field, and with one or two exceptions, they were all found to agree.

EASTERN CIRCLE.

32. Bihār and Orissa.—During the year under report, No. 9 Party surveyed 11 square miles of reserved forest on the two-inch scale and traversed by theodolite 22 linear miles of forest boundaries in the Hazāribāgh district. In the Santāl Parganas, theodolite traverses of 86 linear miles were run round the boundaries of the 3 reserved forests in that district.

33. Upper Burma (*Northern Circle*).—No. 10 Party surveyed the Nansonti, Puga and part of the Nantan reserves in the Myitkyinā division, and parts of the Nami and Nansiaung forests in the Kathā division, amounting to 57 square miles on the two-inch scale.

Part of the Pidaung game reserve in the Myitkyinā district, area 164 square miles, was surveyed on the one-inch scale.

In addition to these, 159 linear miles of boundary survey were completed round the Nantan, Puga, Teinlon and part of the Nansonti reserves of the Myitkyinā division, and round parts of the Nami, Nansiaung, Manmaw, Nanhin, Mawhun and Loimaw reserves of the Kathā division. The Conservator of Forests, Northern Circle, agreed to the survey of the Pidaung reserve being done on the one-inch scale, instead of the two-inch scale, as it is only reserved as a game sanctuary, and not for timber preservation.

34. Upper Burma (*Southern Circle*).—No. 10 Party surveyed the Maymyo reserve of the Mandalay division amounting to 34·7 square miles on the two-inch scale. In addition, 171 linear miles of boundary survey were run round the Maymyo, Taungbyo, Sakangyi and part of the Zibingyi reserves of the Mandalay division.

35. Lower Burma (*Tenasserim Circle*).—No. 11 Party surveyed 95 square miles of the Mintha reserved forest on the two-inch scale, and the remainder of this reserve, together with the Western Hill Range and Taungbyouk reserved forests, on the one-inch scale. Part of the boundary of the Western Hill Range reserved forest, a distance of 54 linear miles (66·4 linear miles with connecting lines), was traversed by theodolite.

36. Assam.—No. 12 Party carried out, on the two-inch scale, the survey of the Chelabor, Sildharampur, Jungthung, Kukrakātā, Garumari and Bhomorāguri reserves in the course of its ordinary operations; the total area amounting to 34 square miles. In addition, the Laokhowa and Kaziranga game sanctuaries, situated within programme limits, were surveyed on the one-inch scale, this scale being considered sufficiently large to meet forest requirements. An area of 20 square miles on the two-inch and 22 square miles on the four-inch scale was completed in the Upper Dihing reserve and 90 linear miles of boundary and interior traversing was run in this and the Jaipur reserve; this survey being a special one, its cost is entirely borne by the Forest Department. The Dabakā, Suang, Bamoni and Diju Valley reserves, comprising an area of 66 square miles which had been surveyed on the four-inch scale in seasons 1904—06, were revised on the 1-inch scale as regards contouring and heights which were found to be faulty in parts.

37. Andaman Islands.—The Andamans Detachment executed the detailed skeleton survey on the scale of 2 inches = 1 mile of 302 square miles of reserved forest (mostly padauk) in the Middle Island of the Andaman Islands and ran 18 linear miles of theodolite traverse for the same purpose.

The survey was executed in continuation of that commenced during the preceding year by the Forest Department, employing surveyors of the Survey of India deputed to it for the purpose.

Operations during the year under report were carried out entirely by Survey of India agency.

III.—CANTONMENT AND LARGE-SCALE SURVEYS.

38. No. 20 Party (Cantonment).—During the year under report, it was employed on the survey of Guna, Kamptee, and Rājkot cantonments, and on Sītābaldi Fort. The triangulation and traversing of Meerut, and the triangulation of Dehra Dūn and Sanāwar have been completed in advance for season 1914-15. The contouring of Saugor was completed during the months of July, August, and September; and traverse work was started in Dehra Dūn in August. The fair mapping of Quetta, Quetta Civil Station, Quetta Fort, Saugor (out-line) and Guna has been sent for publication.

Since August 1913, the strength of the party has been increased by ten pupil surveyors, and three draftsmen. The training of the pupil surveyors has been systematically carried out, and next season there will be eight pupil surveyors quite capable of doing independent work. This will increase the out-turn of the party, and the work will be done at lower cost-rates.

The mapping of Kamptee, Sītābaldi Fort, and Rājkot is in hand, and will soon be sent for publication. The programme for the ensuing year is the survey of Meerut, Bābūgarh Stud Farm, Sahāranpur Remount Depôt, Dehra Dūn and Landour cantonments; and the triangulation and traversing in advance of Jullundur and Peshāwar for survey in 1915-16.

Out-turn and cost-rates of Cantonment Surveys, 1913-14.

Cantonments.	Scales.	Out-turn. Acres.	Total cost.	Cost-rates per acre. Survey and mapping.	REMARKS.
			Rs.	*Rs.*	
Guna, Kamptee, and Rajkot ...	16″=1 Mile	13,019	35,943·82	2·76	
Sitabaldi Fort ...	36″=1 Mile	175	878·81	5·02	
Guna, Kamptee, and Rajkot ...	64″=1 Mile	528	6,273·47	11·88	
		13,722	43,096·10		

39. The Punjab Riverain Detachment.—This Detachment continued the work of traversing and laying down base lines. 2,435 linear and 485 square miles of minor traverse were run. 10,471 theodolite stations were fixed in the area under water action of the rivers Sutlej, Rāvi, Chenāb and Jhelum, in districts Jullundur, Lahore, Siālkot, and Gujrāt. 726 corners of 242 squares were demarcated, in 401 square miles, with permanent mark-stones on both banks of the Rāvi (district Lahore), and the Jhelum (districts Gujrāt, Jhelum and Shāhpur), to serve as bases for the future survey and demarcation of boundaries in the bed of these rivers. 2,151 plotted and 506 boundary "*nasavis*" (settlement mapping sheets) of 309 villages were completed, and 33 four-inch sheets and 4 one-inch indexes were traced; all being supplied in time to the Settlement Officers of Jullundur, Lahore, Siālkot and Gujrāt. Besides these, 227 miscellaneous traces were prepared, and all the traversed stations marked during the season, were plotted on the four-inch sheets. 5 four-inch riverain boundary sheets were finally completed.

40. *The Khushab Thal* (*sandy area*) *survey* was carried on, in continuation of the last year's work. 103 linear and 200 square miles were traversed, and 180 theodolite stations laid out. 63 dressed stones, and 182 iron tubes were embedded over the whole of *Thal* in suitable places, to facilitate future survey and demarcation. 83 plotted and 5 boundary *nasavis* and 16 four-inch traces showing compiled boundaries, were supplied to the Settlement Officer, Shāhpur.

41. *The Kangra* (*tahsils Palampur and Kangra*) *special survey* was commenced on the 15th December 1913, and was temporarily stopped in the middle of July 1914. 40 to 50 stations per square mile were laid out in the cultivated area. The scale of survey was generally 20 *karms*, or 150 feet to 1-inch. With a view to reduce the cost of the work, and save jungle clearing, the boundaries running in thick forests and along inaccessible snowy ranges were left out in 145 square miles of the Pālampur tahsil, and are being enlarged from the topographical survey sheets. In all 3,396 linear and 400 square miles were traversed and triangulated, 16,827 theodolite stations fixed in 1,433 *tikas* (sub-villages) of the Pālampur and Kāngra tahsils, and 16 square miles of boundaries enlarged. 250 boundary *nasavis* of 30 tikas, 5,881 plotted *nasavis* of 1,224 *tikas*, and 31 four-inch sheets were completed.

42. Under orders of the Punjab Government the *25-acre Rectangular Survey* was started on the 21st February 1914 in the tract commanded by the *Upper Jhelum canal* along the Chenāb river in the districts of Gujrāt and Shāhpur, and finished on the 12th June 1914. The detachment was required only to form blocks, subsequently to be split up by the Settlement Department into 25-acre rectangles. The northern and southern sides were demarcated at every 1,100 feet, and the eastern and western ones at every 990 feet, with permanent mark-stones and bricks.

Nearly the whole work was checked with a theodolite Traverse.

1,605 corners of the rectangles forming 38 blocks were demarcated covering 9,186 25-acre rectangles or 359 square miles 663 linear miles were traversed, and 1,605 theodolite stations fixed.

43. Simla Survey Detachment.—This Detachment was formed during the year in order to comply with the needs of the Simla Municipality who urgently required a complete and up to date map, in connection with the improvement schemes of the station.

The area concerned lies within the limits of the Municipality, and comprises 8·386 square miles; country ranging from 6 to 8,000 feet above sea level, with heavily wooded spurs and intricate details over the inhabited portions.

44. During the course of the year the programme of work has been increased and includes the following:—

(a) Large scale detailed plans of all *bazar* blocks in and around Simla.

(b) Survey of extensions, outside Simla, on a scale of 8 inches to 1 mile.

(c) Maps of forests lying in Koti State, (Simla)—Scale 4 inches to 1 mile.

During the year field surveys of 2,418 acres, or about half the station, have been completed, on a scale of $\frac{1}{1,500}$ or 125 feet to 1 inch.

No drawing has been taken in hand yet, as the surveyors, besides being continuously employed in out-door work, have prepared traces of field sheets, plans of *bazar* blocks, supply of heights and other information needed by officials dealing with the Simla Improvement Scheme.

IV.—TRIGONOMETRICAL SURVEYS.

GEODETIC SURVEYS.

45. No. 13 Party.—Astronomical Latitudes.—This party was employed on latitude observations at 10 stations on the Western Ghâts and the West-Coast, and at 4 stations in the United Provinces, as shown in the following list.

The observations were taken in hilly country or in the neighbourhood of hills, and therefore it is not possible to analyse the results until the effects of the attraction of the mountain masses have been computed.

An outstanding feature is the anomaly of the plumb-line deflections in the neighbourhood of Bombay. The pendulum observations have disclosed an excess in the intensity of gravity at Kolâba and a marked defect at Alîbâg. This would lead one to expect that the plumb-line deflections at Alibâg and Kankeshwar would differ from that at Kolâba. We find, however, that the deflection in the meridian at both these stations is about 10 seconds North—just about the same as at Kolâba. Until more pendulum observations are made, no solution of this anomaly can be arrived at.

46. No. 14 Party.—Pendulum Operations—This party carried out pendulum observations, for measurement of the force of gravity, at 10 stations, along a line extending from Alibâg near Bombay, to Pâli in Mârwâr, Râjputâna, as shown in the following list. The chief point of note in the results was a great change in the force of gravity between Alibâg and Kolâba. Neither the neighbouring topography, nor the latitude observations in the neighbourhood afford any explanation of this anomaly, so it has been decided to take further pendulum observations in this area. The preponderance of positive residuals in all the stations is noteworthy, and indicates a general excess in the force of gravity on the West-Coast.

List of Astronomical and Gravity stations, 1913-14.

Astronomical Latitudes.						Gravity Observations.					
Station.	Height.	Long.		Lat.		Station.	Height.	Long.		Lat.	
	Feet.	°	′	°	′		Feet.	°	′	°	′
Parnera ...	614	72	59	20	33	Alibag ...	12	72	52	18	39
Karanja ...	997	72	59	18	51	Daman ...	15	72	50	20	25
Alibag ...	10	72	52	18	39	Surat ...	30	72	48	21	10
Mirya ...	473	73	18	17	2	Broach ...	51	72	59	21	42
Kumbhari ...	2,898	74	20	15	9	Baroda ...	109	73	11	22	19
Chaukola ...	2,794	73	59	15	56	Ahmadabad ...	156	72	34	23	01
Mahabaleshwar	4,719	73	43	17	55	Deesa ...	465	72	12	24	15
Mira Dongar ...	1,863	73	12	18	41	Abu ...	3,836	72	43	24	36
Kalsubai ...	5,400	73	45	19	36	Erinpura ...	872	73	04	25	09
Godhna ...	846	77	57	29	37	Pali-Marwar ...	719	73	19	25	48
Mehesari ...	811	78	11	29	30						
Ranigarh ...	7,055	78	43	30	4	Also repeat observations at Dehra Dun at beginning and end of season.					
Harpalsid ...	1,000	78	36	29	40						
Kankeshwar ...	1,260	72	58	18	44						

TRIANGULATION.

47. No. 15 Party.—Was employed during the season in carrying out the following series of Principal and Secondary Triangulation:—

(*a*).—PRINCIPAL TRIANGULATION.

(i).—The Sambalpur Series.—The three figures required to complete the southern end of this series were observed. The total length of the completed series is 331 miles, and the final connection with the East-Coast series is very satisfactory.

(*b*).—SECONDARY TRIANGULATION.

(ii).—Nāgā Hills Series.—(Previously named the *Manipur Series*).—The connection of this series with the Manipur Longitudinal Series was completed. A large discrepancy in latitude was disclosed and is being made the subject of further investigation. The Assam earthquake of 1897 has made the interpretation of all results in this area very complicated.

(iii).—Jaintiā Hill Series.—The continuation of this old series to make connection with the new Nāgā Hills series was nearly completed in regard to building stations, but observations were only completed for the eastern half.

(iv).—The Buldāna Series.—(Previously named the *Akola Series*).—The northern half of this series carrying it down to latitude 20° 12′, was completed. This is all that is required for current topographical purposes, and the series will not be carried further at present.

(v).—The Ashta Series.—This connection between the Karāchi Longitudinal and Khandwā Series, along the meridian 76° 30′, was commenced, and completed with the exception of 36 miles at the north end.

(vi).—The Naldrug Series.—Was carried due south from the Bombay Longitudinal Series, along the meridian 76° 30′, down to latitude 15° 30′, whence it turned eastwards and was closed on the Great Arc Series, making a satisfactory connection.

(vii).—Bombay City and Island Frame-work.—The triangulation and traverse required as a basis for the new Bombay City Survey were completed, and all data supplied to the Superintendent of the City Survey. An analysis of the results shows that the desired accuracy of 1 in 10,000 was well maintained throughout the work.

Particulars of Triangulation during 1913-14.

	PRINCIPAL.	SECONDARY.				
	Sambalpur.	Nāgā Hills.	Jaintiā Hills.	Buldāna.	Ashta.	Naldrug.
Number of Stations observed at	5	12	6	20	16	32
„ „ newly built	.....	1	14	20	19	28
Distance in miles completed ...	52	127	45	104	100	265
Distance remaining to be done	.....	.....	57	.....	36	0
Area of triangulation in sq. miles	1,444	2,200	370	1,431	1,037	4,429
Number of triangles observed ...	.....	9	4	18	14	32
„ „ Azimuths „ ...	1	...	...	...	...	...
Maximum triangular error ...	0″·316	4″·26	No connection.	0″·98	3″·07	4″·94
Average „ „ ...	0″·119	1″·23		0″·44	1″·07	2″·16
Mean closing error in latitude...	0″·155	1″·59		No connection.	No connection.	0″·15
„ longitude	0″·040	0″·02				0″·30
„ height ...	2·5 ft.	11·8 ft.				10 ft.
„ azimuth...	3″·185	10″·56				17″·84
Theodolite used	T & S 12-inch Micr. No. V.	T. & S. 12-inch Micr. No. III.	T. & S. 12-inch Micr. No. III.	T. & S. 8-inch Micr. No. 1311.	T. & S. 8-inch Micr. Nos. 1315 & 1316.	T. & S. 8-inch Micr. No. 956.

TIDAL OPERATIONS.

48. No. 16 Party.—Observations were taken by means of self-registering tide-gauges during the year, at the stations given in the following list :—

Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.		Remarks.
1. Aden	1879 ...	Still working	35		
2. Karachi ...	1868 ...	1880	*13	47	*Small tide-gauge working.
	1881 ...	Still working	34		
3. Bombay (Apollo Bandar)	1878 ...	,,	36		
4. Bombay (Prince's Dock)	1888 ...	,,	26		
5. Madras ...	1880 ...	1890	10	29	
	Restarted 1895	Still working	19		
6. Kidderpore	1881 ...	,,	33		
7. Rangoon	1880 ...	,,	34		
8. Moulmein ...	1880 ...	1886	6	11	
	Restarted 1909	Still working	5		
9. Port Blair	1880 ...	,,	34		

In addition to the above, tidal diagrams registered by a small river-gauge at Chittagong, and readings of high and low water taken during day-light on tide-poles at Bhaunagar and Akyab were supplied by the Port Officers concerned.

Tidal registrations at all the observatories now working have, on the whole, been carried out satisfactorily. The registrations at Madras which were stopped in August 1913, as stated in last year's report, were resumed at the old observatory in November 1913, owing to the accretion of sand, which blocked the passage between the sea and the observatory well, having been partially removed by the North-East monsoon. The erection of the new observatory at Madras was completed in February 1913 and tidal registrations were started in it on the 21st of the same month, when the old observatory was abandoned. All the above observatories were inspected during the year. Tidal observations during the coming year will be continued at the nine observatories now working.

49. In the following table are given the annual and decadal percentages of errors in the predicted times and heights of high and low water at all the stations where observations have been taken :—

Percentage of errors in predicted times and Heights

Year.	At open coast stations.						At riverain stations.					
	Number of stations.	In Time.		In Height.			Number of stations.	In Time.		In Height.		
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.
		H.W.	L.W.	H.W.	L.W.	H.W.—L.W.		H.W.	L.W.	H.W.	L.W.	H.W.—L.W.
1904 ...	6	82	75	99	98	96 96	2	45	61	72	65	94 95
1905 ...	7	82	79	96	95	96 97	2	52	62	72	57	94 92
1906 ...	6	85	81	96	97	94 95	2	59	53	74	64	92 95
1907 ...	6	84	83	98	98	98 99	2	58	47	78	60	96 90
1908 ...	6	84	84	98	97	99 99	2	58	52	77	60	97 92
1909 ...	6	85	86	97	97	97 98	3	61	59	69	65	93 92
1910 ...	6	81	83	98	98	95 96	3	57	52	63	71	89 94
1911 ...	6	84	84	98	99	97 98	3	65	51	68	66	90 90
1912 ...	6	82	82	97	98	97 98	4	70	58	74	62	94 91
1913 ...	6	83	82	97	97	98 99	4	68	55	70	58	94 88
Average of ten years	...	83	82	97	97	97 98	...	59	55	72	63	93 92

LEVELLING OPERATIONS.

50. No. 17 Party.—Three detachments were employed on levelling during the past season, as follows:—

51. *No. 1 Levelling Detachment* was employed in the Punjab on the lines (*a*) *new levelling* extending the line Ambāla-Solon to Simla along the tonga road and the "Mall," with branch lines to "Prospect Hill" and "Jakko",—and (*b*) on the *revisions* of the old lines Jagādhri-Ambāla-Ludhiāna and (*c*) Ferozepore-Lahore, by road.

This detachment also carried out in Baluchistān (*d*) *new levelling* extending the line Shikārpur-Jacobābād to Quetta, along the railway line as far as Sibi, and thence along the main road.

The out-turn of work amounted to 432 miles, and the heights of 15 primary, and 507 secondary bench-marks were determined, including 1 Principal Station of the Great Trigonometrical Survey.

52. *No. 2 Levelling Detachment* was employed in Bengal on *new levelling* on the lines (*a*) Mymensingh-Dacca, partly along the railway line and partly by road, (*b*) Howrah-Champdāni by road, part of the line which will eventually be carried on to Benares, (*c*) Tindhāria-Darjeeling, with branch lines to the cantonments of Lebong and Takdah—and (*d*) on a *revision* of the old line of single levelling Pāchuriā-Porādaha along the railway line. This revision work disclosed an error of 1·784 feet in the old levelling.

In addition to the above, the Brahmaputra at Dhubri, Meghnā, Lakhyā, Dhaleswari, Padmā or Ganges rivers were again crossed; for the first four crossings, vertical angles were observed, and for the last the "Target" method was adopted.

The out-turn amounted to 223 miles including 11 miles of check levelling on the above-mentioned river banks; and 41 primary, and 194 secondary bench-marks were connected, including 3 Secondary Stations of the Great Trigonometrical Survey.

The revisionary line Pāchuriā-Porādaha closes the circuit Porādaha-Pārvatīpur-Gauhāti-Akhaurā-Pāchuriā-Porādaha with a closing error of 1·084 feet, the length of the circuit being 824 miles.

53. *No. 3 Levelling Detachment* was employed in Burma on the line (*a*) Taunggyi-Thazi, by the P. W. D. unmetalled road to Tagundaing, and thence by the railway line to Thazi, (*b*) Magwe-Taungdwingyi, by the P. W. D. unmetalled road, (*c*) Mokpolin-Amherst, along the western embankment of the Sittang Canal to Kyaikto, and thence along the P. W. D. unmetalled road to Martaban, whence the levels were carried across the Salween river to Moulmein by vertical angles, and thence by P. W. D. road, *via* Mudon and Kwanhla to Amherst.

The out-turn amounted to 321 miles and the heights of 3 new and one old primary, and 93 new and 21 old secondary bench-marks were connected.

The line Magwe-Taungdwingyi completes the circuit Rangoon-Thazi (Meiktila Road)-Prome-Henzada-Rangoon, 882 miles in length, with a closing error of 0·287 of a foot.

54. Of these various lines of levelling two have been run from the plains to the hills, *viz*:—Thazi to Taunggyi in Burma, and Jacobābād to Quetta, in the Central Brāhui range, Baluchistān; and two are extensions further into the hills of lines emanating from the plains, *viz*:—Solon to Simla, and Tindhāria to Darjeeling, both in the Himālayas.

Introduction of a new System of Levelling.

55. The present system of levelling of precision in India is that initiated by General Walker in 1858. It is "*Simultaneous double levelling*". In this system each line is observed by two levellers working independently under practically identical conditions. Each line is divided into a number of sections according to the convenience of the work, and the total length of sections levelled in one direction is made equal to that done in the opposite direction.

At the International Geodetic Conference of 1912, a resolution was passed that in future there would be a new category of levelling to be called "*Levelling of high precision*", and that to qualify for this category each section of a line of levels must be levelled independently in both the *forward* and the *backward* directions on dates as widely different as possible, and that the errors calculated according to certain formulæ must not exceed certain limits.

The main object of this new system is to evaluate the systematic or cumulative error dependent on the direction in which the levellers move. In the "*Simultaneous double levelling*" this error cannot be evaluated, because every section is worked in the same direction, and not fore and back, by both levellers. It is, however, eliminated from the final result by the system of levelling alternate sections in opposite directions.

During the past season two lines were worked on the new system of "*fore and back double levelling*" *viz* :— Ferozepore to Lahore, and Jacobābād to Quetta. Each section was, however, levelled on the same day, a plan which, though not quite in accordance with the above resolution, has several points in its favour. Henceforward the system of "fore and back double levelling" will always be employed.

MAGNETIC SURVEY.

Committee on the present position of the Magnetic Survey.

56. At the suggestion of the Surveyor General a committee was appointed by the Government of India in March 1914 to consider the present position of the magnetic survey and advise as to the steps to be taken to complete it. The committee, consisting of Dr. G. T. Walker, C.S.I., F.R.S., as president, and Captain Thomas and Mr. J. deGraaff Hunter, of the Survey of India, as members, sat for a fortnight in March 1914.

The report of the committee will be published in extenso in the Records of the Survey of India; the main conclusions and recommendations may be summarised as follows:—

(*i*).—The field work of the first general magnetic survey is complete and the work of reduction to epoch should now be pressed on.

(*ii*).—The process of reduction usually followed may be simplified and the labour involved thereby considerably reduced.

(*iii*).—The survey can be brought up to date at any future period by maintaining an adequate number of observatories in continuous operation and by preservation of the present repeat stations.

57. No. 18 Party (Magnetic).—As it was considered desirable to push on with the reduction of the mass of data already accumulated, detailed survey operations were discontinued, and field work was confined to observations at repeat stations for the determination of secular changes and comparisons of instruments at observatories. This work was carried out by two detachments under the Officer in charge and a Provincial officer.

In December 1913, however, the party was directed to carry out special detailed magnetic surveys in the districts of Poona, Nāsik, and Ahmadnagar, in connection with the proposed establishment of one of the stations of the Imperial chain of wireless telegraphy. A third detachment under a provincial officer took the field for this purpose, but after completing work in the Poona district, amounting to 30 stations in all, instructions were received to discontinue the operations. It is difficult to draw any useful conclusions from the magnetic survey of a narrow belt of country where (as in this case) local disturbances of considerable magnitude are of frequent occurrence; within the limits of this survey, however, there was no evidence that the topographical features exerted any appreciable magnetic effect

58. *Work during recess.*—The reduction and the tabulation of the data for the four survey base stations for 1913 have been completed. The mean values for the year 1913 derived from all days, excluding those of great disturbance, are given in the table below.

The computation of the field observations during 1913-14 has been completed, and that of the observatory work during 1914 has made good progress.

The reduction of the field observations in Horizontal Force to the selected epoch, has been put in hand; hitherto only the declination data have been dealt with.

59. Mean values of magnetic elements.—The mean values of the magnetic elements at the survey base stations for 1913 derived from "all" days, are as follows:—

Observatory.	Latitude & Longitude.	Dip.	Declination.	Horizontal Force.	Vertical Force.
	° ′ ″	° ′	° ′	C. G. S.	C. G. S.
Dehra Dun ...	30 19 19 N 78 3 19 E	N 44 16·4	E 2 22·2	·33191	·32359
Barrackpore ...	22 46 29 N 88 21 39 E	N 30 54·8	E 0 38·0	·37388	·22387
Toungoo ...	18 55 45 N 96 27 3 E	N 23 5 0	E 0 7·8	·38963	·16605
Kodaikanal ...	10 13 50 N 77 27 46 E	N 4 5·5	W 1 11·2	·37553	·02686

BASE LINE OPERATIONS.

60. No. 19 Party.—During the year the various parts of the Bar Comparators, including the Standard Bars themselves, and of the apparatus for ascertaining the length of the wires which are used for field measurements, arrived from Europe. Some progress was made in the erection of both the Comparators, but as they cannot be used until electric power is available, and as the scheme for the supply of power to Dehra Dūn was not likely to be complete till the autumn of 1914, no great amount of labour was expended on them.

The officer in charge was employed at the Head Quarter Office of the Trigonometrical Survey under the orders of the Superintendent.

61. The set of Standard Bars received from Europe comprises the following:—

Pure Nickel Bar	...	1 metre in length.
Invar Bar	...	1 „ „ „
Nickel-Steel Bar	...	1 „ „ „
Invar Bar	...	4 metres „ „
Nickel-Steel Bar	...	4 „ „ „

The lengths and co-efficients of expansion of the 4-metre bars were determined at the National Physical Laboratory, Teddington; those of the 1-metre bars at the Bureau International des Poids et Mesures, Sevres. All the bars are of similar cross-section, the long ones being more massive than the others, and they were all constructed and graduated by the "Société Génevoise des Instruments Scientifiques". Details of these lengths and co-efficients of expansion, are being published in Volume VII of the "Records of the Survey of India".

V.—GEOGRAPHICAL SURVEYS AND EXPLORATION.

62. The Italian Scientific expedition to the Karakoram.—Under the direction of Cavaliere F. deFilippi, after a visit to Dehra Dūn in August 1913 for comparison of instruments, proceeded to the Karakoram, *viâ* Kashmīr and Leh. *Differential Longitudes* between Dehra Dūn and points on the upper reaches of the Indus as far as Leh, on both sides of the Karakoram Pass, and in Chinese Turkistān, were determined by the simultaneous recording of *wireless* telegraphic signals sent out by the Lahore Radio-Office, combined with Astronomical observations. The Government of India have given various facilities besides a monetary contribution to this expedition, and the results should prove of particular interest to geodesy and kindred sciences. Major H. Wood, R.E., proceeded to join the expedition in March 1914, and field work was closed in November 1914, by observations at Tashkent.

63. Sir Aurel Stein's archæological Expedition in Central Asia.—Two picked surveyors from the department remained with this expedition throughout the year, and are reported to have collected much geographical information of areas hitherto unexplored.

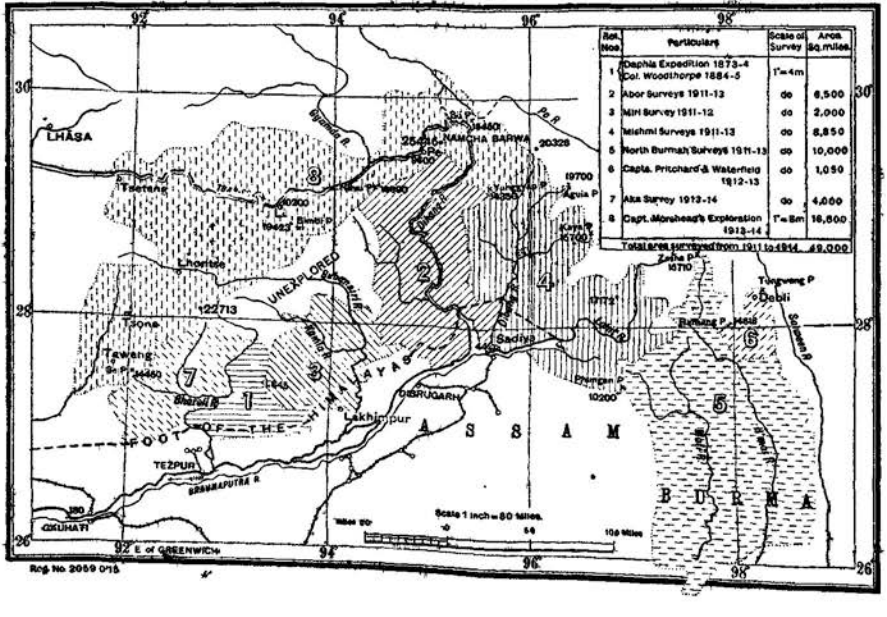
64. Eastern Himalayas.—Captain F. M. Bailey, I.A., with Captain Morshead, R.E., of the Survey of India, returned in November 1913 from 6 months' exploration in the neighbourhood of the unknown portions of the Tsan-po, or Upper Brahmaputra river. A general description and map of their journeys may be found in the "Geographical Journal" for October 1914. The work resulted in some 16,600 square miles of reconnaissance, together with much valuable information, in regard to an area hitherto almost unknown.

Though the great bend of the Tsan-po has been shifted some sixty miles eastward of its previously estimated position, the main fact of the identity of the Tsan-po with the Brahmaputra river has been fully established, and the results have justified the faith of the department in their explorer Kinthup, who traversed these regions in 1880—84. Another interesting discovery was that the highest peak of this region (Namcha Barwa 25,445 feet) is in the great bend of the Tsan-po—a fact whose probability had already been suggested by Sir Sidney Burrard in "The Geography and Geology of the Himalaya Mountains" (1907).

65. North-East Frontier.—Some additional exploration was carried out during the year under report, in continuation of that executed on the Northern Frontier of Assam during the two immediately preceding seasons. This was done under Lieutenant Huddleston, R.E., who accompanied a small political mission into the Aka country, lying to the west of the Abors and north and west of the Miris. With 2 Indian surveyors under him he succeeded in completing the survey and reconnaissance of 4,040 square miles of country, 3,400 square miles of which had hitherto been unsurveyed, and in forming a connection with the work of Captain Morshead along the water-shed of the Bhareli River System.

66. The index map below shows roughly the areas embraced in the various explorations on the North-East Frontier of India and North Burma during the past 3 years.

INDEX TO EXPLORATIONS ON N. E. FRONTIER.



PART 3.—OFFICE WORK.

I.—HEAD QUARTER OFFICES.

MAP PUBLICATION OFFICE (*vide* Index maps at end.)

67. The classes of maps, for the publication of which the Head Quarter Offices are responsible, may be enumerated as follows:—

(*a*)—Topographical maps on the scale of 1 inch to 1 mile.

(*b*)—Topographical maps on the scale of ½ inch to 1 mile.

(*c*)—Topographical maps on the scale of ¼ inch to 1 mile.

(*d*)—Geographical maps on the one millionth scale, (about 16 miles to 1 inch).

(*e*)—Geographical maps on the two millionth scale, (about 32 miles to 1 inch).

(*f*)—General maps on small scales.

(*g*)—Special maps.

The first duty of the offices is to publish the 1-inch, ½-inch and ¼-inch maps prepared by the field parties and Circle drawing offices from the results of the topographical surveys now in progress.

68. *(a)* **Topographical maps on the scale of 1 inch to 1 mile.**

During the year 176 sheets have been received for publication and 158 have been published. The corresponding figures for the previous year were 152 and 222 respectively. The decrease in output is chiefly due to the fact that a large number of the sheets surveyed in 1912-13 were received too late for publication in 1913-14 and are still under publication.

Putting aside the sheets surveyed in Kashmir, where the season of field survey differed from that in other parts of India, the one-inch maps of all areas surveyed up to the 30th September 1913 have been published, with the exception of 57 sheets including an area of about 14,800 square miles; of these, 47 have been drawn and are under publication, and the remaining 10 have not yet been received from the Circle offices.

Index maps Nos. 4, 5 and 6 at the end of this report show the progress made in the publication of the modern one-inch sheets, and the table below gives the annual output of sheets since the modern topographical surveys were begun:—

Year.	Number of 1-inch Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1905-06	...	...	...	...
1906-07	4	1	...	5
1907-08	16	15	22	53
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
1911-12	68	33	58	159
1912-13	104	60	58	222
1913-14	71	38	49	158
Total Published ...	421	266	349	1,036
Approximate number of 1-inch sheets in India ...	2,160	2,067	2,101	6,328
Approximate number remaining for publication.*	1,739	1,801	1,752	5,292

* These figures include large number of sheets in deserts, at high altitudes and in other thinly populated country of which maps on so large a scale as 1 inch to the mile are unlikely to be required.

No important changes in the style of the one-inch maps have been introduced during 1913-14.

In addition to the output of modern one-inch sheets mentioned above, 55 sheets prepared from modern revenue surveys have been received for publication, of which 51 have been published as preliminary editions pending their topographical revision at some future date, and 2 special editions of modern one-inch sheets have been prepared at the request of local Governments to show village boundaries.

To maintain stocks, or to give effect to important changes due to the development of communications, 6 modern one-inch sheets and 9 old-style sheets on various scales have been reprinted.

69. *(b)* **Topographical maps on the scale of $\frac{1}{2}$ inch to 1 mile.** At a conference held at Simla in June 1914, over which the Chief of the General Staff presided, and at which the Surveyor General was present, it was resolved to represent to the Government the desirability of preparing a map of India on the scale of $\frac{1}{2}$ inch to 1 mile, for tactical purposes. Two half-inch sheets have been received for publication and several are being drawn.

70. *(c)* **The map of India on the scale of $\frac{1}{4}$ inch to 1 mile.** (*Vide* Index map No. 9). This map is prepared in "degree sheets" which include 1° × 1°, or the area covered by 16 one-inch sheets.

The following table shows the progress made in publication :—

Years of Publication.	Number of Degree Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1911-12	2	1	1	4
1912-13	3	1	1	5
1913-14	4	3	2	9
Totals	9	5	4	18
Approximate number of degree sheets in India	170	140	140	450

Pending the preparation of the new degree sheets from modern surveys, 28 degree sheets have been published during the year as Provisional Issues. These have been prepared from the maps of old surveys.

Seventy-four Atlas sheets and 6 district maps on the same scale, ($\frac{1}{4}$ inch to 1 mile), have been reprinted.

71. *(d)* **Geographical maps on the one millionth scale,** (about 16 miles to 1 inch). (*Vide* Index map No. 10).

Almost the whole of India has now been mapped in the India and Adjacent Countries series of sheets on the scale of $\frac{1}{1,000,000}$. The more recently published sheets, including 3 new sheets published during the year, are contoured and printed with hypsometrical layers, and the other sheets will gradually be contoured and republished with hypsometrical layers. A few selected sheets of this series are being engraved.

The only important change introduced during the year in the design of these maps has been the adoption of the method of showing areas under perpetual snow and ice in white, with the addition of light shading.

The scale of altitude tints for the one millionth maps is still the subject of experiments. The results attained so far are satisfactory, but it is hoped that further improvement can be effected.

72. La Carte Internationale du Monde au 1,000,000e.—One Indian sheet namely, sheet North 43 E, (Bombay), has been engraved and published. (*Vide* Index map No. 11).

An International Committee, which assembled in London under the auspices of His Majesty's Government in November 1909, decided that it was desirable that an International Map of the World, on the scale of 1:1,000,000, should be produced in a uniform style, prescribed by the committee, and that the respective governments should prepare and publish the sheets of the map in which their territories were included. At that time the Government of India had already begun the preparation of its own series of maps on the 1:1,000,000 scale, and these differ in several important features from the International Map, more particularly in the size of the sheets which include $4° \times 4°$ instead of the $4° \times 6°$ of the International sheets, and in the use of the foot instead of the metre as the unit of height measurements. The Indian sheets could not be altered to agree with the International sheets, as they form the key to the whole system of numbering and arrangement of the Indian topographical maps, and because the heights and contour values must be shown on them in feet. In order, therefore, to conform to the international movement, it is necessary to produce the international sheets as a special series, in addition to, and after the production of, the corresponding sheets of the Indian series.

Several sheets of the International Map of the World have now been published; the Government of Great Britain has produced at least 3, including portions of the British Isles and Turkey; the French Government has produced one or more sheets of French territory; the Government of the United States one of a portion of New England. Most of these sheets differ in certain particulars from the specifications prescribed by the committee of 1909, and from each other. They have aroused much interest and discussion among geographers and map makers in all civilised countries.

In November 1913, the International Committee met again at Paris and passed a new series of resolutions regarding the project, under which several of the conventional signs and the system of layer colouring have been changed.

Sheet North 43 E, was engraved in accordance with the original specifications of 1909, but the scale of layer colouring applied to it is that prescribed by the Paris Committee of 1913. It has, for the Survey of India, an interest apart from its being the first International sheet the department has published. It is also the first engraved sheet produced at Calcutta in colours from separate colour plates, a process which in the climate of Bengal presents certain difficulties not met with to the same extent in Europe.

Three other sheets of the International Map of the World are now being engraved at Calcutta.

73. *(e)* **Geographical Maps on the scale of $\frac{1}{2 \text{ Million}}$** (about 32 miles to 1 inch). (*Vide* Index map No. 12).

Three sheets, "Northern Persia", "Afghānistān", and "Baluchistān", of the Southern Asia Series, scale $\frac{1}{2 \text{ Million}}$, have been published during the year. These, together with the sheet "Southern Persia", previously published, will, when joined up, provide a modern map of Persia for which there has been a constantly increasing demand in recent years.

It has been decided to extend the mapping of this series over India. One sheet, Kāthiāwār, is being drawn and the compilations of three others, the 'Andamans', 'Bombay' and 'Madras' have been put in hand.

74. *(f)* **General Maps on small scales.**

The Map of India and Adjacent Countries 1913, scale 32 miles to 1 inch, in 12 sheets, has been published with hypsometrical layer colouring.

This is believed to be the largest layered map of its kind yet printed and it is now the most important geographical map of the Indian Empire. The numerous problems it has presented in connection with the selection of the altitude zones and their colouring have been solved with a certain measure of success, but it is believed that several improvements can be effected, and experiments are now in hand with this object in view.

The preparation of the Political Edition of the same map, which will not be layered but will be coloured to distinguish the various administrative areas, is at present in abeyance pending the receipt of orders from Government in regard to certain boundaries.

The annual edition of the Railway Administration Map of India, scale 64 miles to 1 inch, showing information up to the 30th June 1914, was produced in August, together with a special edition of the same map showing important works in progress.

75. *(g)* **Special Maps:**—A large number of special maps, plans, diagrams and illustrations have been prepared for the different departments of Government, for Army Head Quarters, and for officials throughout India. Among these may be mentioned the Peshāwar Divisional Manœuvre Map, scale 4 miles to 1 inch, and a map of the lay-out of Delhi, scale 4 inches to 1 mile.

Heavy calls on the map reproducing offices in connection with the war kept certain sections at work night and day during a part of August and September.

In addition, and in response to a wide demand on the part of the public, a series of war maps of Belgium and parts of France, Germany and Russia were produced on different scales; the sales of these maps had amounted to Rs. 22,000 by the end of the year.

76. The number of maps issued during 1913-14 (as shown at the foot of this page) is again in excess of those of previous years.

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77. Map Record and Issue Office.—The gross face value of the maps received from the printing offices during the year amounted to Rs. 3,26,077. This sum includes Rs. 7,117 and Rs. 26,848 the face value of maps printed in the Engraving Office and at Dehra Dūn respectively.

Details of the numbers and classes of maps published during the year, and their face value are shown in Table IV on page 32.

The total number of printed maps issued during the year was 3,59,917 of aggregate value of Rs. 1,77,546.

The details of the sales were as follows:—

	Government Officials.	*India Office.*	*Departl. Issues.*	*Private Individuals.*	*Map Agents.*	**Totals for 1913-14.**	*Totals for 1912-13.*
No. of maps	2,56,380	4,081	52,410	35,826	11,220	**3,59,917**	3,27,311
Value	*Rs.* 71,253	*Rs.* 5,031	*Rs.* 52,612	*Rs.* 32,391	*Rs.* 16,259	**Rs. 1,77,546**	*Rs.* 1,69,760

78. No. 1 (Head Quarter) Drawing Office.—During the year under review, the office was engaged in compiling and drawing the $\frac{1}{M}$ India and Adjacent Countries series of maps. Layers were prepared for several sheets of which new editions were required, to make them conform to the latest style. Four sheets of the $\frac{1}{M}$ International series, in which heights are in metres, are in progress, and partly with the Engraving Office. The drawing of three sheets of the Southern Asia series, scale $\frac{1}{2\text{ Million}}$, (about 32 miles to 1 inch), was completed. General maps of India on various scales were also dealt with. Of these the most interesting is the new layered edition of the 1 inch=32 miles wall-map of India. This map displays, at a glance, the main topographical features of the Indian Peninsula and the Himálayas and the Tibetan Plateau.

The preparation of the Degree sheets (1 inch=4 miles) from the old Atlas sheets, where new material was not available, has been continued.

Thirty maps on various scales have been brought up to date for the purpose of providing reprints.

A large number of sheets drawn by field parties and circle offices have passed through the office for minor corrections, contouring and stump-shading, or for the preparation of the layered editions.

A section has been formed to deal with a new ½-inch series of maps to cover India. Two sheets are already well advanced and should be ready for publication in 1915.

Indexes, Provincial and District maps, large-scale plans of towns and cantonments, have also been in hand during the year.

Seventy-seven sheets of Extra-Departmental work were drawn. Among these were maps and plans for the Postal, Geological, Railway, and Settlement authorities, and also special manœuvre maps.

The work of the Office-Copy Section which records all new material that has come into existence since a map was published, dealt with over three thousand sheets inserting new railways, canals, main-roads, and changes of boundary. This information is brought to notice by local authorities. The material thus collected is inserted in the new editions of the smaller scale maps which may be called for. In addition to this work, the section examined nearly 6,000 coloured maps before they were issued to the public. Traverse data have also been supplied to Settlement Officers and Engineers to enable them to make maps and plans for special purposes. Another class of work is the preparation of attested true plans of large scale surveys for use in court proceedings.

79. Engraving Office.—The engraving of the International Map N. E. 43 on four separate plates for four-colour printing was completed during the year. This is the first engraved map in four colours that has been prepared in the office. Good progress is being made with the other International Sheets N. D. 44, N. E. 44 and N. F. 42. Two others will shortly be put in hand.

Ten sheets of the $\frac{1}{M}$ "India and Adjacent Countries" Series have been taken in hand, of which Nos. 47, 53 and 63 are nearing completion, while the others 39, 41, 46, 48, 49, 56 and 72 are in various stages.

Eleven Index maps to complete the series of indexes to standard sheets were completed. Four scales and five layer tints were engraved.

Corrections and additions have been made to the General maps of India, several Index charts, district maps and old $\frac{1}{M}$ maps, as well as to other miscellaneous plates.

A number of certificates and Commission forms for the Army Department in English, Urdu and Hindi were also engraved.

In the Copper-plate-printing Section over 31,000 impressions were pulled, including photogravure plates. Work in connection with the making of transfers for printing purposes has so largely increased, partly owing to the introduction of layered maps, that two new motor-driven presses have been brought out and will shortly be set up.

In the Electro-typing Section 185 plates were dealt with.

80. Photo.-Litho. Office.—There has been a decrease in departmental work, due, in part, to the number of one-inch sheets in colours received for publication being considerably less than in 1912-13. The out-turn of Extra-Departmental work, however, shows a marked increase, and this has enabled the office to show an increase in the total number of maps printed during the year.

The total number of new *one-inch standard sheets* printed is 158. In addition 5 one-inch standard sheets in colours were reprinted to replenish stock, while of preliminary and provisional editions, 8 sheets were printed in black and brown, and 41 sheets in black only. These together bring the total number of sheets printed in modern form to two hundred and twelve, a decrease of 40 sheets as against 1912-13, but maintaining an increase of 23 sheets as compared with 1911-12.

Further progress has been made and experience gained in the manner and method of printing *layered maps*. The most important undertakings of the office have been the 32-mile layered map of India in 12 sheets, and sheet No. N. 43 E. of the International Layered Map of the World.

The total *number of impressions pulled* is 2,286,845, an increase of 320,387 over the previous out-turn of 1,966,458 in 1912-13, itself an increase of 401,962 over the preceding year.

There has been a very large increase in the number of sheets received for the reproduction of *half-tone hill-shading* the number of negatives having increased from 53 in 1911-12 and 42 in 1912-13 to 153 during the year under report.

A new "Levy" acid-blast *etching-machine*, to etch plates 27 inches by 24 inches for use with either nitric acid or perchloride of iron, is on order and is shortly expected from England. The machine is guaranteed to etch a flat tint of the above size quite evenly, and should prove a great boon to the office.*

One additional Double-Demy, flat-bed *printing machine* has been received from England and is now in process of erection, while one further Quad-Crown and one Quad-Demy machine are on order from Messrs. Mann & Co.; it is hoped that both will be received and erected in 1915, the latter at the beginning and the former towards the end of the year.

An indent has also been submitted for two new *graining machines*.

The Stores Section, re-organised in 1913, has worked in a satisfactory manner, and the improved system of book-keeping then introduced has materially added to its efficiency.

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* This machine was lost on the S. S. "Chilkana", captured and sunk by the "Emden". Another has been ordered.

Out-turn of Photo.-Litho. Office during 1913-14.

1	2	3	4	5	6	7	8
Year.	Cost of office.	Value of out-turn at cost-rates.	Recovered in cash or by book-debit.	Number of impressions pulled. (Litho. only here shown).	Number of maps printed.		
					Depart-mental.	Extra-Depart-mental.	Total.
	Rs.	*Rs.*	*Rs.*				
1911-12	1,47,867	2,01,394	24,904	15,64,496	2,686	1,263	3,949
1912-13	1,61,699	2,39,940	27,214	19,66,458	3,656	2,010	5,666
1913-14	**1,67,801**	**2,40,721**	**33,468**	**2,286,845**	**2,965**	**2,779**	**5,744**

In addition, there were 35,710 half-tone pulls and 875,000 line-block pulls, (chiefly Weather Charts).
as against 51,370 ,, ,, and 530,280 ,, ,, in 1912-13.
and 60,056 ,, ,, and 437,820 ,, ,, in 1911-12.

The output of the Type Section is not included in the above statement.

The Type Section published 6,403 pages or items, 12,03,242 copies, 21,32,159 impressions.
as against 8,408 ,, or ,, 13,43,465 ,, 26,08,591 ,, in 1912-13.
and 7,988 ,, or ,, 11,31,012 ,, 20,14,766 ,, in 1911-12.

81. Mathematical Instrument Office.—During the year, from 1st April 1913 to 31st March 1914, there has been a large increase in the demands made on this office (*vide* item No. 1 in the table below) with the result that, whereas there was a loss of Rs. 7,055 in the previous year's working of the 'Stores' department, there has been a net profit of Rs. 33,571 in that of the past year.

The improvement in the value of work done, which showed a profit of Rs. 2,887, in the 'Workshop' department for 1912-13, has been well maintained, the profit during the past year being Rs. 10,346.

Below are given the usual comparative figures for the last three years :—

	1911-12.	1912-13.	1913-14.
	Rs.	*Rs.*	*Rs.*
1. Total issues to Public Offices as shown in the Profit and Loss statements of stores.	3,25,633	2,84,315	4,07,802
2. Value of repairs to instruments received for repairs and returned in a serviceable condition.	55,941	64,452	56,418
3. Value of instruments received from Government Officers when no longer required.	37,228	57,267	69,806
4. Book value of the stock of instruments, &c., in Serviceable Stores.	7,46,047	6,45,081	4,73,470
5. Book value of the stock of instruments, &c., in Repairable Stores.	70,460	72,452	67,299
6. Total value of work done in the Workshop ...	1,74,871	2,15,328	2,40,752
7. Value of instruments manufactured in Workshop for Serviceable Stores.	61,431	74,188	93,991
8. Value of instruments purchased locally ...	4,578	6,206	9,060
9. Value of instruments and materials obtained from England through the Director General of Stores.	47,148	57,647	89,213
10. Average No. of employés and their pay ...	No. 297 } Rs. 62,981 }	No. 301 } Rs. 68,625 }	No. 300 } Rs. 76,734 }

During the year the stock of all the three stores, (the Serviceable, the Repairable and the Material Stores), was twice taken and the discrepancies noticed have been adjusted.

A number of certificates and Commission forms for the Army Department in English, Urdu and Hindi were also engraved.

In the Copper-plate-printing Section over 31,000 impressions were pulled, including photogravure plates. Work in connection with the making of transfers for printing purposes has so largely increased, partly owing to the introduction of layered maps, that two new motor-driven presses have been brought out and will shortly be set up.

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Table IV.—Departmental Publications, Calcutta, 1913-14.

Note.—For special publications at Dehra Dun, *vide*, pp. 33, 34, and 35.

Class of Maps.	Scale.	Number of different maps of each class received.		Number of copies printed.	Value.
		New Publications.	New Editions and reprints.		
GEOGRAPHICAL MAPS.					*Rs.*
Maps of India	Various	3	6	3,402	9,286
Southern Asia Series	1:2,000,000	3	2	6,600	19,800
India and Adjacent Countries ...	1:1,000,000	3	4	3,450	3,450
Do. (International Series) ...	1:1,000,000	1	.....	239	469
TOPOGRAPHICAL MAPS.					
DEGREE SHEETS.					
Modern	1"-4 miles	9	9	9,895	10,395
Preliminary and Provisional ...	Do.	.....	3	1,400	1,400
From Atlas Material	Do.	28	1	9,248	9,248
ONE-INCH SHEETS.					
Modern	1"-1 mile	158	6	83,814	82,164
Do. (Preliminary Editions) ...	Do.	51	.....	21,900	20,900
Do. (Village Boundary Editions)	Do.	2	.....	400	800
Old Style Sheets	(2"-1 mile to 1"-4 miles)	4	9	5,094	7,641
Atlas of India Series	1" 4 miles	.....	74	10,370	9,729
Provincial Maps	Various	.....	4	1,800	2,250
District Maps	1"-4 miles	1	6	2,300	2,300
Administration Report Maps ...	(1"-8 miles to 1"-16 miles)	....	16	1,950	731
Plans of Cities and Cantonments ..	Various	5	.....	1,475	1,475
Index Maps ...	Do.	84	.....	1,42,764	35,798
Miscellaneous Maps	Do.	376	13	2,68,309	1,08,250
Totals for 1913-14	.....	**728**	**153**	**5,74,101**	**3,26,077**
Corresponding totals for 1912-13 ...	.....	611	311	...	2,28,331

LETTERPRESS.

1. Reproduction of Maps, Plans, Photographs, Diagrams and Line Illustrations. Photo.-Litho. Office. *Price Rs. 3.*
2. Index to names appearing on the Northern Persia sheet of the Southern Asia Series. Scale $\frac{1}{2\,M}$.
3. Index to names appearing on the Southern Persia sheet of the Southern Asia Series. Scale $\frac{1}{2\,M}$.
4. Catalogue of Maps of the Bombay Presidency. *Price As. 4.*
5. Record Volume No. 3 for the year 1911-12. *Price Rs. 4.*
6. ,, ,, No. 4 ,, 1911-12-13. *Price Rs. 4.*
7. ,, ,, No. 5 ,, 1912-13. *Price Rs. 4.*
8. Report on Electro-typing. F. Harrison, Esq., Ordnance Department, Southampton.
9. Topo. Handbooks, Chapters Nos. 1, 2, 3, 6, 7 and 9. (*Reprints*).
10. Map Publication orders from 1st January 1908 to 1st June 1914.

II.—DEHRA DÚN OFFICES.

82. COMPUTING AND TECHNICAL OFFICES.—Comprising Computing Office, Type Printing Office, Stores and Workshop, Observatories.

Computing Office.—Among other work carried out by the Computing Office the following may be mentioned:—

Computations of graticules for maps, of dynamic and orthometric heights on the lines of levelling from Delhi to Muttra, Murree to Srīnagar, Srīnagar to Islāmābād, Islāmābād to Aishmakam, Srīnagar to Chunār, Srīnagar to Manasbal and Srīnagar to Bugam: and also preparations for press of the lines Minbu to Paugma and Paugma to Salin. The investigation of large discrepancies in azimuth of Lambton's triangulation brought to notice by No. 15 Party. Computation of mean triangular error of all Principal and Secondary Series. Computation of azimuth observations made by Lieutenant Nosworthy at three stations near Dehra Dūn. Calculation of the azimuth of Cairo and Singapore from points in India, in connection with the selection of a site for a wireless station. Computations in connection with isostasy and changes in the earth's axes. Compilation of data for 44 triangulation charts. Adjustment of topographical triangulation and computation of Lieutenant Huddleston's triangulation in the Aká country. Extraction of data from records in response to a large number of various enquiries.

83. Printing Office.—The following publications were printed during the year:—

(1) Report of the Committee appointed by the Government of India to discuss the present state of the Magnetic Survey.

(2) Note in reply to Mr. Hayden's paper on the relationship of the Himálaya to the Indo-Gangetic Plain and the Indian Peninsula. *By Lieutenant-Colonel G. P. Lenox-Conyngham, R.E.*

(3) Note in vindication of Kinthup. *By Captain G. F. T. Oakes, R.E.*

(4) Departmental Paper No. 6.—Levelling of High Precision. *By M. Ch. Lallemand* (Translated from the French. *By J. deGraaff Hunter, M.A.*)

(5) Records of the Survey of India, Vol. VI.—Completion of the link connecting the triangulations of India and Russia.

(6) Spirit-levelling pamphlets No. 39 and new edition of Nos. 54 and 58.

(7) Large numbers of professional forms have also been printed, as the whole of these are now supplied from Dehra Dūn.

(8) The printing of the following publications is in hand:—

(*a*) Professional Paper No. 15.—Pendulum Operations in India, January 1908 to April 1913. *By Captain H. J. Couchman, R.E.*

(*b*) Departmental Paper No. 7.—The Bar Comparisons of 1907-8. *By Major H. M. Cowie, R.E.*

(*c*) Records of the Survey of India, Volume VIII.—Exploration in Tibet and neighbouring regions.

84. Stores and Workshops.—Experiments have been made with a trestle for triangulation in wooded country. The chief difficulty is to get rid of vibration and movements which disturb the instrument, and considerable progress has been made in overcoming this.

An instrument for calculating the attraction of mountain chains has been designed by Mr. deGraaff Hunter and made. A "versine staff", for reading the correction to chained lengths due to slope of ground, has been made to the design of Major E. A. Tandy, R.E.

85. Observatories.—*Meteorological observations* have been continued throughout the year as mentioned in para. 93 of last report. A partial reduction of these results has been made and the corresponding refractions computed. The result points to a regular seasonal change in refraction. Further observation is necessary to establish this.

The Omori Seismograph has been in action throughout the year, and a list of earthquakes recorded will be published in the Records of the Survey of India, Volume VII.

Photographs of the sun were taken on 333 days during the year, the sun being obscured by clouds on the remaining days.

In collaboration with the *Expedition of Cavalieri F. deFilippi* observations for longitude by means of wireless telegraphy have been made successfully. This is the first occasion on which wireless telegraphy has been employed in the department. Eight stations have been connected, *viz.*,—Skārdu, Kargil, Lamayuru, Leh, Depsang Plains, Suget Karaul, Yārkand and Kashgar. The last three are beyond the Karakoram Range and previously some doubt was felt as to whether the signals could be received over a great mountain range. It is satisfactory to record that the signals were received clearly and without difficulty.

86. Preservation of Trigonometrical Stations.—778 stations were repaired by district officers at a cost of Rs. 3,772. Out of 352 districts from which reports are annually due, 13 failed to make returns.

87. No. 2 DRAWING OFFICE.—The following is a summary of the work of the office during the year 1913-14.

Class of map.	Sheets sent to press.	Remaining in hand.
Scientific Diagrams and Charts	5	Nil
Geographical maps $\frac{1}{1,000,000}$ scale	Nil	9
Do. smaller scale ...	10	12
Miscellaneous Indexes and Plans	2	14
Triangulation charts	17	28
Extra-Departmental maps	3	1
Cantonment maps	10	3
Total ...	47	67

88. Photozinco. Office.—During the year the lithographic machine was employed in printing standard and provisional Degree Sheets; sheets of the plan of the site of the new Capital at Delhi; Cantonment and Forest maps; Triangulation and Levelling Charts.

Abstracts of the work done in the Photozinco. Section during 1912-13 and 1913-14 are shown in the following table:—

Year.	Subjects.	Negatives.	Pulls.	Chocolate and Cyanotype prints.
1912-13 ...	1,973	1,909	2,36,766	1,039
1913-14 ...	2,046	2,376	2,44,140	1,695

The letter-press machine was employed in printing departmental forms, &c. It was transferred from this office to the Computing Office on the 31st August 1914.

89. Forest Map Office.—The total number of maps issued during the year, both to officials and the public, amounted to 6,441, a decrease of 3,166 on last year's total. The gross face value of these maps was Rs. 12,301 and the net amount realized from sales was Rs. 2,348 against Rs. 3,191 in the previous year. Of this amount, Rs. 1,552 was recovered by book-debit and Rs. 796 by cash from sales to private individuals and trading companies. The number of maps and field sections received for storage during the year was 6,746, besides 224 computation volumes, angle books and traverse field books and 61 traverse charts and plot sheets.

The following table shows the work dealt with:—

Class of map.	Number of sheets.		
	In hand.	Drawn and sent to press.	Published.
1-inch, 2-inch and 4-inch maps of Forest Surveys	285	62	35
Provincial, Divisional and District Forest maps ...	13	7	6
Working Plans and Miscellaneous maps ...	11	13	12
Totals ...	309	82	53

III.—CIRCLE AND LOCAL DRAWING OFFICES.

90. No. 3 Drawing Office (Northern Circle).—During the year 116 fair sheets were received in the Circle Drawing Office. The fair sheets included the maps of the "Sārdā River-Nepāl boundary" series, which have been held in abeyance awaiting a decision regarding the boundary, and those of Māler Kotla and environs, which were examined and sent to press.

Altogether 101 fair sheets were sent to press during the year, made up of 88 current sheets and 13 which were received from parties in season 1912-13. The number of sheets in hand on the 30th September 1914 was 28.

100 proofs were received from the Superintendent, Map Publication during the year, and 67 were examined and returned to press. On the 30th September 1914 there were 34 proofs in hand.

During the year under report 4 Degree sheets were sent to press. On the 30th September 1914 there were 9 Degree Sheets in hand.

91. No. 4 Drawing Office (Southern Circle).—Forty-nine one-inch sheets and 1 half-inch sheet were finally examined, 3 preliminary one-inch sheets were re-drawn and the drawing of three degree sheets was completed. All these sheets were submitted for publication.

At the end of the year only 1 one-inch sheet of those surveyed up to the end of 1912-13 remained to be submitted for publication, and 6 preliminary one-inch sheets and 6 degree sheets were being re-drawn and drawn respectively.

A number of pupils were instructed in drawing and considerable assistance was given to parties to enable them to complete their drawing during the recess season.

The Photo.-Zinco. Section undertook the photographic and zincographic work required in the circle.

92. No. 5 Drawing Office (Eastern Circle).—The work of the Office during the year was the examination of the parties' one-inch sheets, 1 half-inch sheet, and the drawing of degree sheets.

In addition to the draftsmen lent to the parties during the recess season, one surveyor and one draftsman were transferred to No. 10 Party at Maymyo, for employment in the Degree Sheet Section of that party.

During the year 35 one-inch sheets, 1 half-inch sheet, and 1 degree sheet, were submitted for publication. One one-inch sheet has been withheld, owing to the examination being incomplete for want of one of its field sections, but will be submitted shortly.

One degree sheet has been sent for publication during the year. 36 degree sheets are now in hand. Several of these will shortly be ready for submission to Superintendent, Map Publication. These sheets were thrown back owing to want of draftsmen, caused by transfers to parties to help in the one-inch mapping. 10 of them are being drawn in the Degree Sheet Section of No. 10 Party at Maymyo, but it is proposed to discontinue work on 3 of them, as well as on 12 of those being drawn in No. 5 Drawing Office, in order to allow of a commencement being made in these offices at as early a date as possible with half-inch mapping.

Proof and colour patterns of 49 one-inch sheets and 4 degree sheets have been dealt with.

93. Bihār and Orissa Drawing Office.—(*Imperial Mapping Section*). The office submitted the fair drawings for the publication of 55 preliminary one-inch sheets covering an area of 10,810 square miles. The drawing of 11 other sheets is practically completed, but they have been retained pending references in connection with settlement operations, and that of 57 sheets is in hand. There remain 31 sheets in Bihār and Orissa, for which cadastral plans are available, the one-inch preliminary mapping of which has yet to be taken up.

The following special maps were also drawn:—

(*i*).—Darjeeling Municipality, scale 20 inches to 1 mile, in 6 sheets.

(*ii*).—Darjeeling, "The Happy Valley", scale 20 inches to 1 mile, in 1 sheet.

(*iii*).—Darjeeling, (Central portion), scale 40 inches to 1 mile, in 2 sheets.

(*iv*).—Darjeeling Bazar, Native Town and Lloyd's Botanical Garden, scale 60 inches to 1 mile, in 1 sheet.

(*v*).—Lebong Cantonment, scale 30 inches to 1 mile, in 3 sheets.

(*vi*).—Takdah Cantonment, scale 30 inches to 1 mile, in 6 sheets.

The first four of these maps were submitted for publication to the Director of Surveys, Bengal and Assam, and the last two to the Superintendent of the Trigonometrical Survey.

The Bihār and Orissa Drawing Office will be transferred at an early date to Bankipore, and arrangements have been made, with the approval of the Government of Bengal, for the accommodation of the Imperial Mapping Section of the office in the Bengal Drawing Office, where, together with a similar section which will shortly be formed to undertake the preliminary 1-inch mapping of Cadastral Surveys in Bengal, it will work under the supervision of the Director of Bengal Surveys.

PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS.

94. Northern Circle.—As in previous years the *Punjab Riverain Detachment* of the Northern Circle was exclusively employed on the Riverain Khushāb *Thal* and Kāngra Traverse and Triangulation and 25-acre rectangular surveys required by the Punjab Government (*vide* page 15).

No. 20 Party (*Cantonment*) has been employed during the year under report on the survey of the following Cantonments:— Guna, Kamptee, Rājkot and Sitābaldī fort and also on the triangulation in advance, of Dehra Dūn and Sanāwar (*vide* page 14).

The Simla Survey Detachment was formed during the year and has been employed on the survey of Simla Municipality and suburbs (*vide* page 16).

95. Southern Circle.—During August and September 1914 Captain Browne with 3 surveyors, &c., surveyed the site for the *Kirkee Wireless Station* and marked the astronomical azimuths required for the aerials.

96. Eastern Circle.—Two probationary superintendents of the Burma *Land Records Department* were attached to No. 10 Party for *training* in survey for 8 months. They carried out 35 square miles of detail forest survey on the 2-inch scale, and 43 linear miles of theodolite traverse near Maymyo, which has been incorporated in the Revision survey of the locality now in course of execution.

97. General.—Two Imperial officers with a staff of surveyors were attached to the *Turko-Persian Frontier* Commission; and one to *Cavalier de Filippi's Scientific Expedition*, with other details as stated on page 23, of the Report.

Two Provincial officers have been lent to the Bombay Government for the *Bombay City Survey*.

Various *Forest Surveys* and forest maps were carried out for the Forest Department as usual.

The Mathematical Instrument Office supplies and repairs instruments for every Government Department in India, including the Army Department.

98. Map Publication Offices.—*The reproduction*, for other departments, of maps, plans, and illustrations that do not require to be redrawn, does not interfere with the normal work of the Survey of India and is always undertaken when asked for. On the other hand, the amount of drawing and compilation that can be done for extra-departmental purposes is limited, and is necessarily confined to urgently required and important work.

During the year maps, plans, or illustrations were reproduced for the following departments and offices:—

The Government of India in the Department of Revenue and Agriculture.
" " " " " Education Department.
" " " " " Army Department.
" " " " " Public Works Department.
" " " Bengal.
" " " The United Provinces.
" " " Punjab.
" " " Bihār and Orissa.
" " " Central Provinces.
" " " North-West Frontier Province.
" " " Delhi.

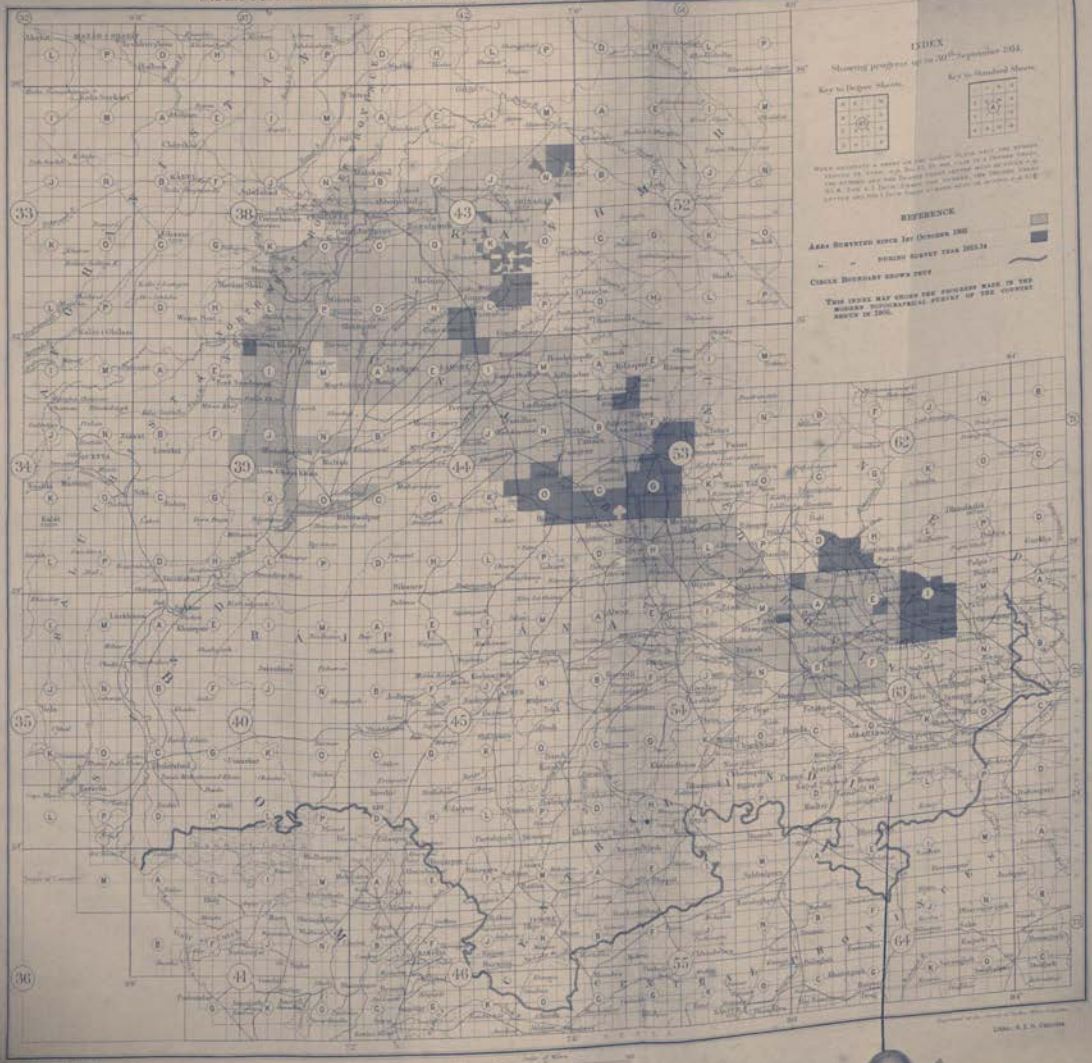
The Comptroller General.
The Railway Board.
The Chief of the General Staff.
The General Officers Commanding Brigades and Divisions.
The Post and Telegraph Department.
The Military Works Department.
The Director of Public Instruction, Bengal.
The Director, Geological Survey of India.
The Superintendent, Port Blair.
The Police Departments of Local Governments.
The Director General of Commercial Intelligence.
The Director, Botanical Survey of India.
The Director of Statistics.
The Director General of Observatories.
The Director General of Archæology in India.
The Consulting Architect to the Government of India.
The Archæological Superintendent for Epigraphy.
The Director of Surveys, Bengal and Assam.
The Director of Land Records and Surveys, Bihār and Orissa.
The Director of Land Records, Punjab.
The Controller of Patents and Designs.
The Principal, Civil Engineering College, Sibpur.
The Assam Bengal Railway.
The E. B. S. Railway.
The E. I. Railway.
The G. I. P. Railway.
The Itārsi Nāgpur Railway.
The Superintendent, Government Printing, India.
" " " Bengal.
" " " Burma.
The Port Commissioners, Calcutta.
The Secretary, Municipal Committee, Delhi.
The Hyderābād Municipality.

Some work was also done for various public bodies and societies.

LIST OF INDEX MAPS.

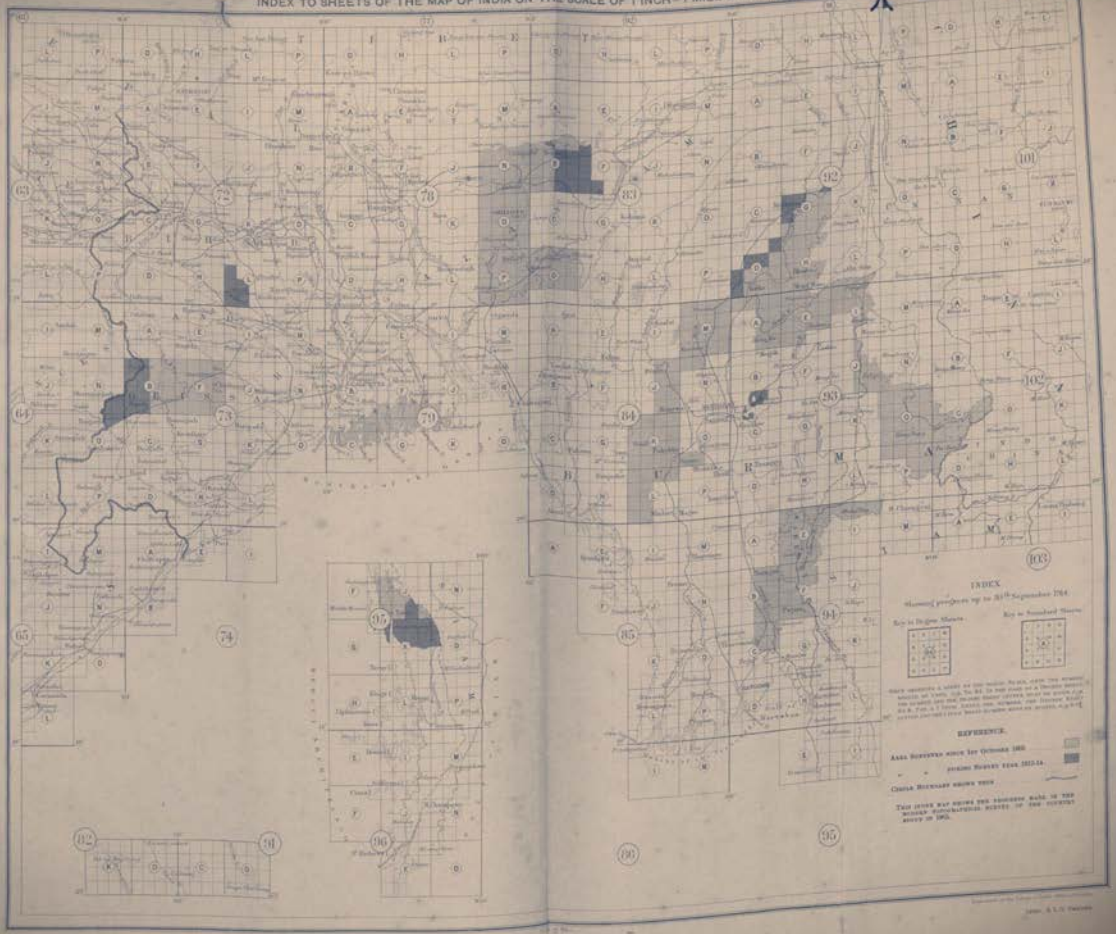
1. Index to modern surveys, Northern Circle.
2. ,, ,, ,, ,, Southern Circle.
3. ,, ,, ,, ,, Eastern Circle.
4. Index to the publication of modern one-inch sheets, Northern Circle.
5. ,, ,, ,, ,, ,, ,, ,, Southern Circle.
6. ,, ,, ,, ,, ,, ,, ,, Eastern Circle.
7. Index to the publication of provisional editions of one-inch sheets, Northern Circle.
8. ,, ,, ,, ,, ,, ,, ,, Eastern Circle.
9. Index to the publication of Degree sheets, scale $\frac{1}{4}$ inch to 1 mile.
10. Index to the publication of sheets of the 'India and Adjacent Countries' Series, scale $\frac{1}{1,000,000}$, or about 16 miles to 1 inch.
11. Index to the publication of Indian sheets of "La Carte Internationale du Monde" on the scale of $\frac{1}{1,000,000}$, or about 16 miles to 1 inch.
12. Index to the publication of sheets of the 'Southern Asia' Series, scale $\frac{1}{2,000,000}$, or about 32 miles to 1 inch.
13. Index to the Great Trigonometrical Survey.

INDEX TO SHEETS OF THE MAP OF INDIA ON THE SCALE OF 1 INCH = 1 MILE (NORTHERN CIRCLE).



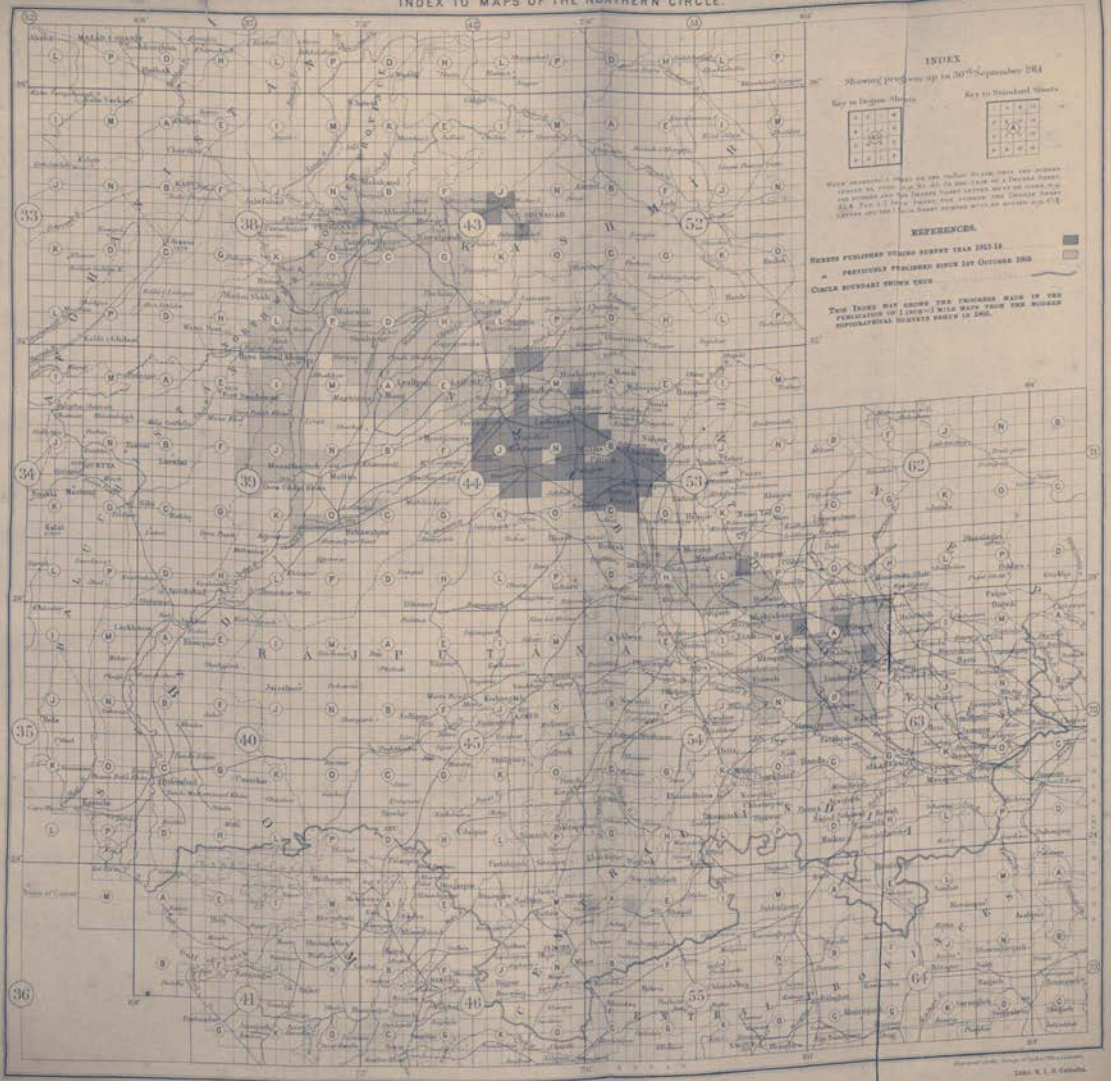
INDEX TO SHEETS OF THE MAP OF INDIA ON THE SCALE OF 1 INCH = 1 MILE (SOUTHERN CIRCLE).

INDEX TO SHEETS OF THE MAP OF INDIA ON THE SCALE OF 1 INCH = 1 MILE (EASTERN CIRCLE).



INDEX TO MAPS OF THE NORTHERN CIRCLE.

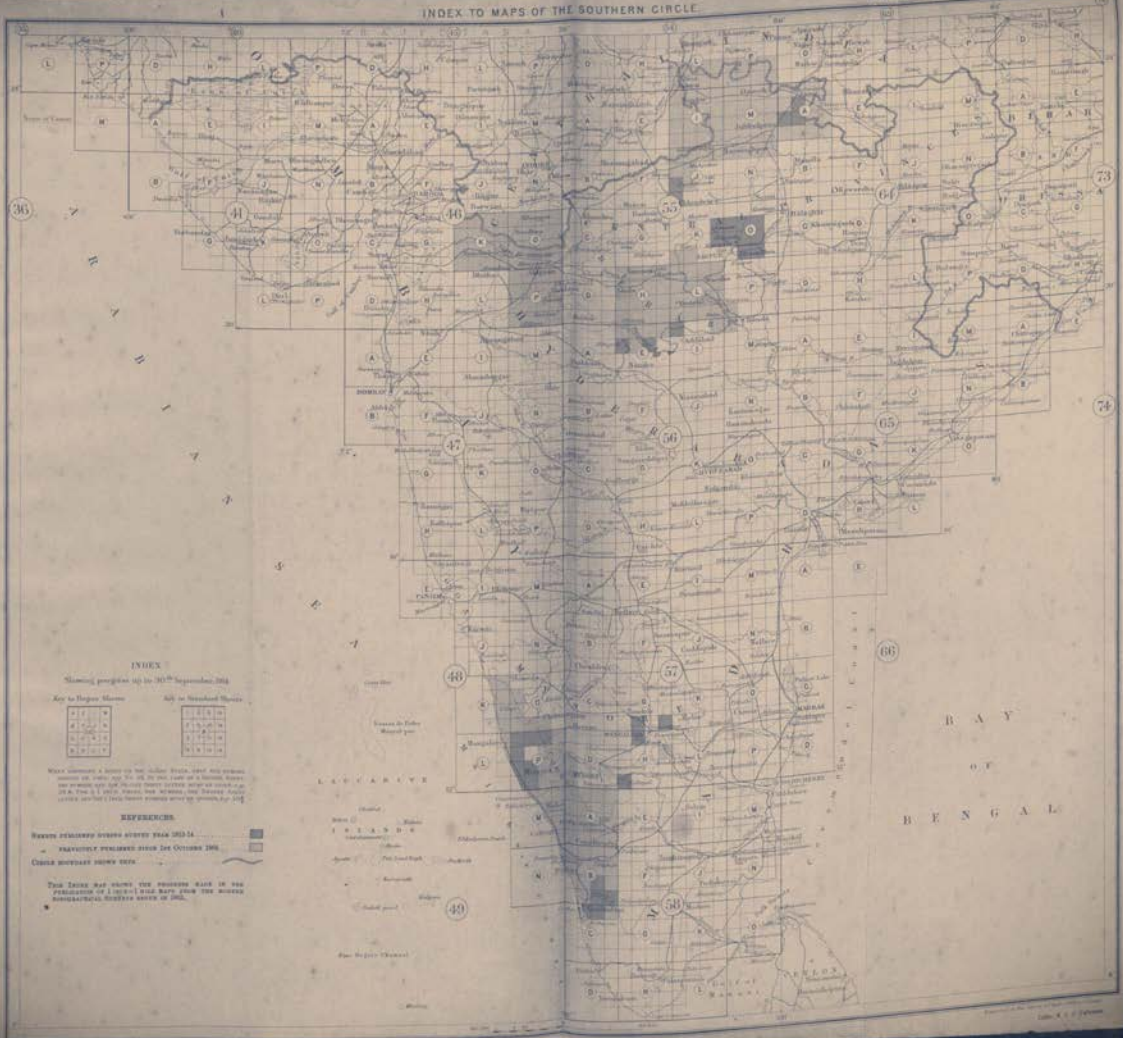
PUBLICATION ON THE ONE INCH SCALE.

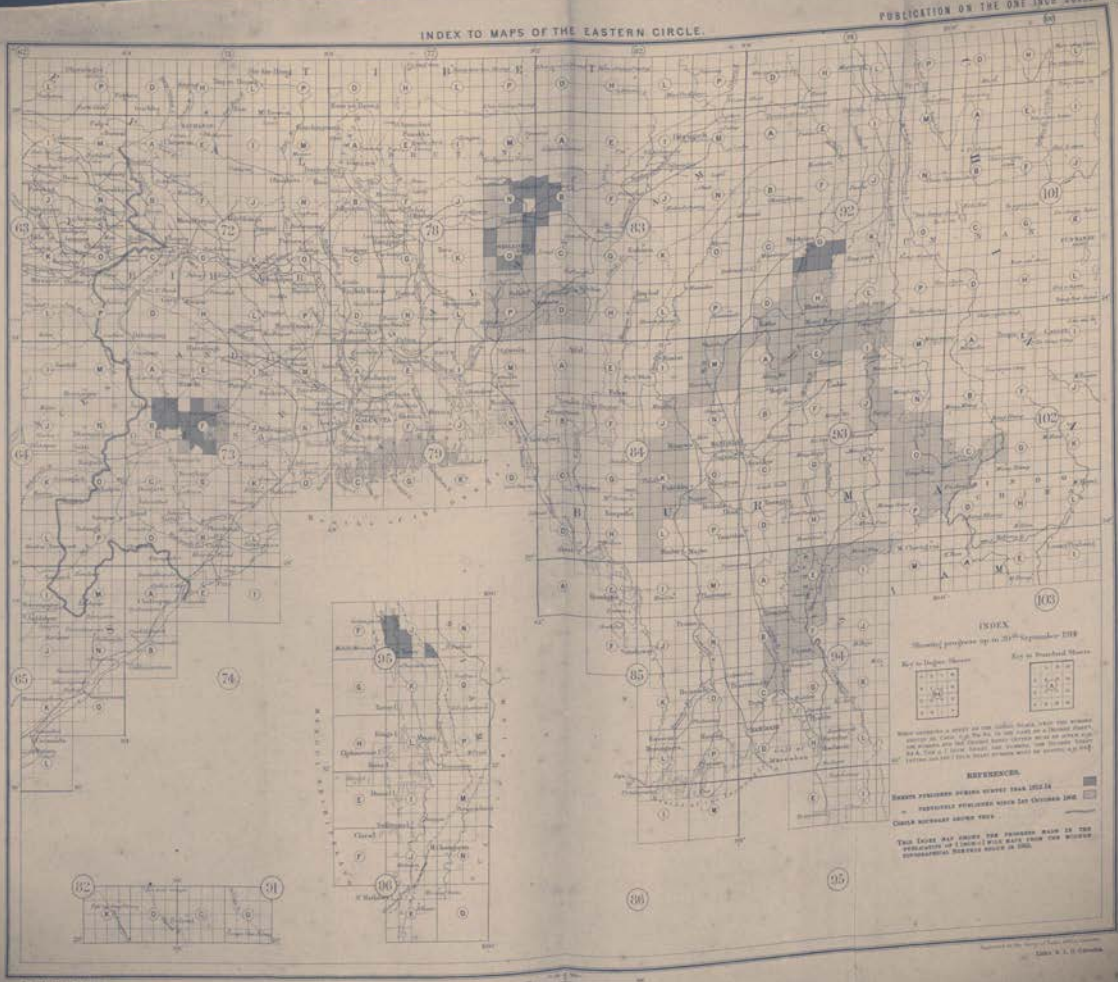


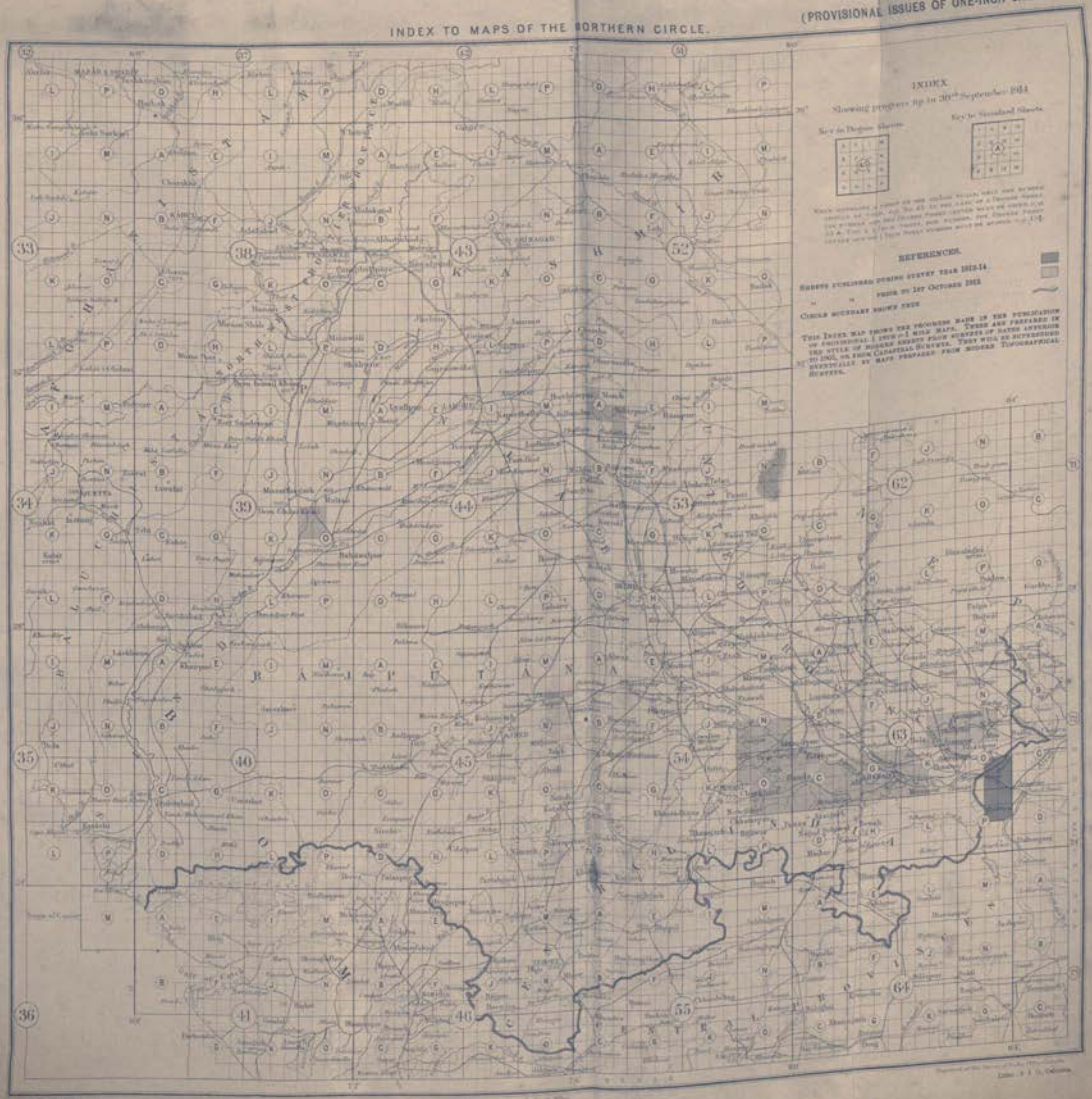
Reg. No. 1858 II, 14,-1200.

Lith. W. I. H. Calcutta.

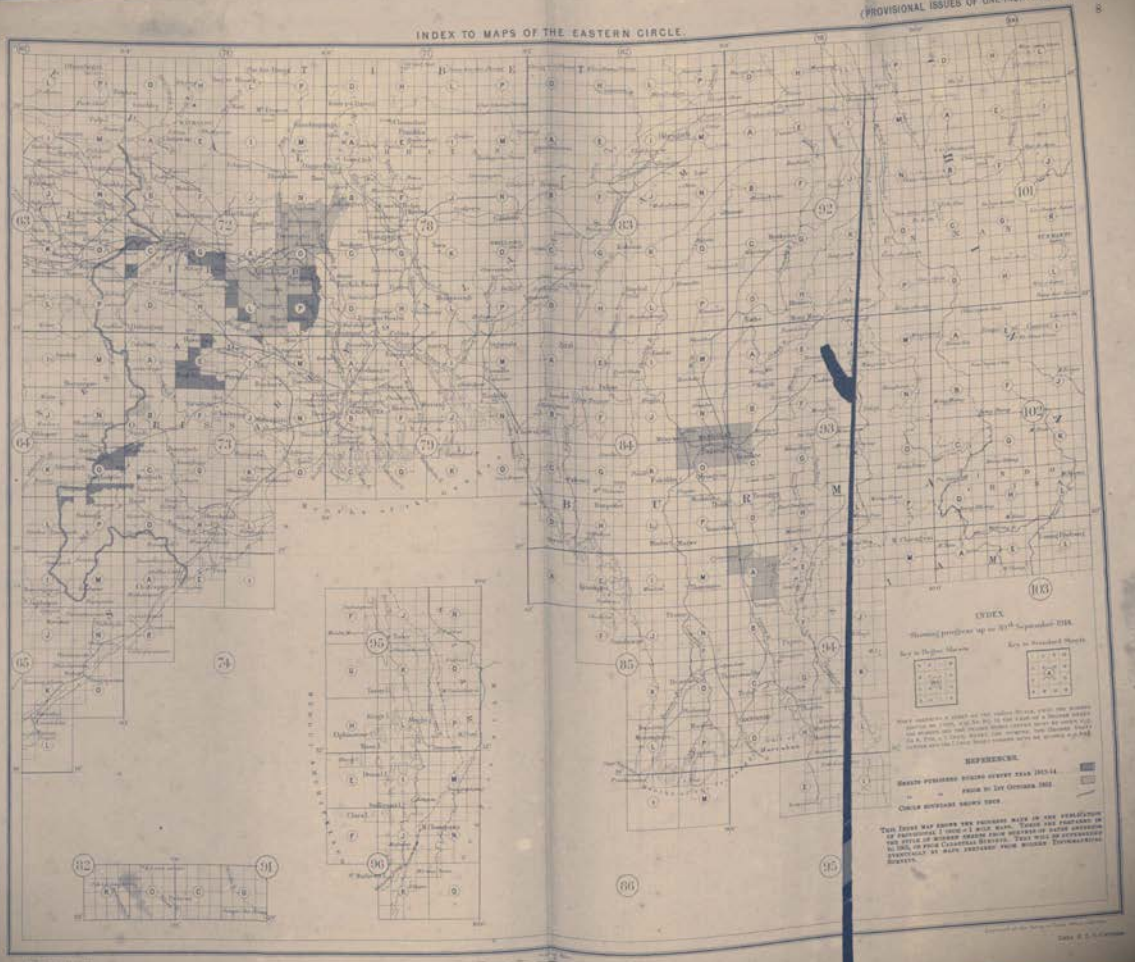
INDEX TO MAPS OF THE SOUTHERN CIRCLE

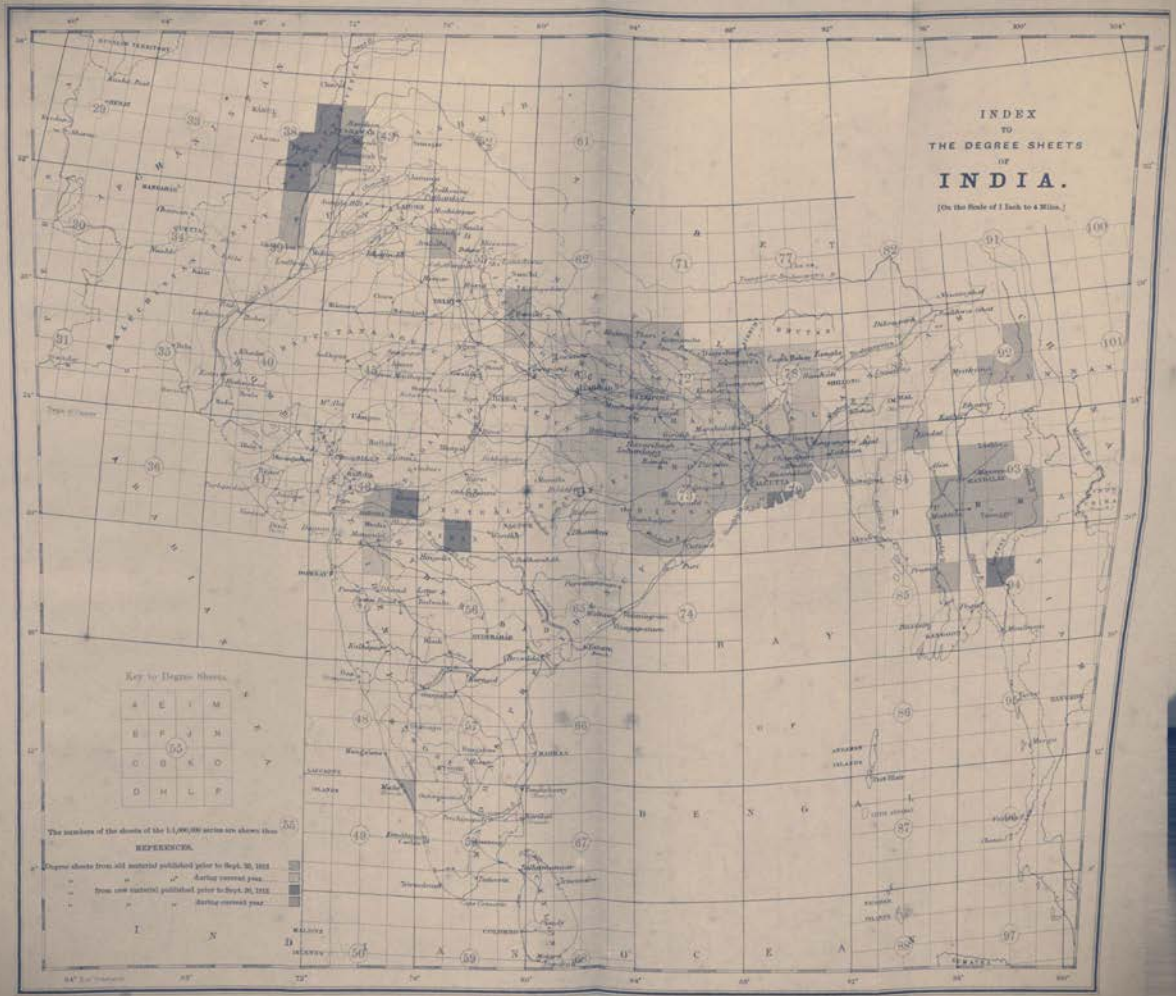

INDEX
Showing progress up to 30th September 1914.
Key to Degree Sheets
Key to Standard Sheets
REFERENCES
Sheets published during the year 1913-14
Previously published since 1st October 1908
Circle boundary shown thus
This Index map shows the progress made in the publication of 1 inch = 1 mile maps from the modern topographical surveys since 1908.
BAY OF BENGAL
LACCADIVE ISLANDS
INDIA


INDEX
Showing progress up to 30th September 1918
Key to Degree Sheets
Key to Numbered Sheets
REFERENCES.
Sheets published during current year 1917-18
Previously published since 1st October 1908
Circle surveyed during 1917-18
This Index map shows the progress made in the publication of 1 inch=1 mile maps from the modern topographical surveys made in 1908.


INDEX
Showing progress up to 30th September 1914
Key to Degree Sheets
Key to Standard Sheets
REFERENCES.
Sheets published during survey year 1913-14
" " prior to 1st October 1913
Circle boundary shown thus
This Index Map shows the progress made in the publication of provisional 1 inch (= 1 mile) maps. These are prepared in the style of modern sheets from surveys of dates attached to each, or from Cadastral Surveys. They will be superseded eventually by maps prepared from modern Topographical Surveys.
MARSH LANDS
NORTH STAFFORDSHIRE
BASIN
MARSH
LEVEL
LEVEL
LEVEL

INDEX TO MAPS OF THE EASTERN CIRCLE.



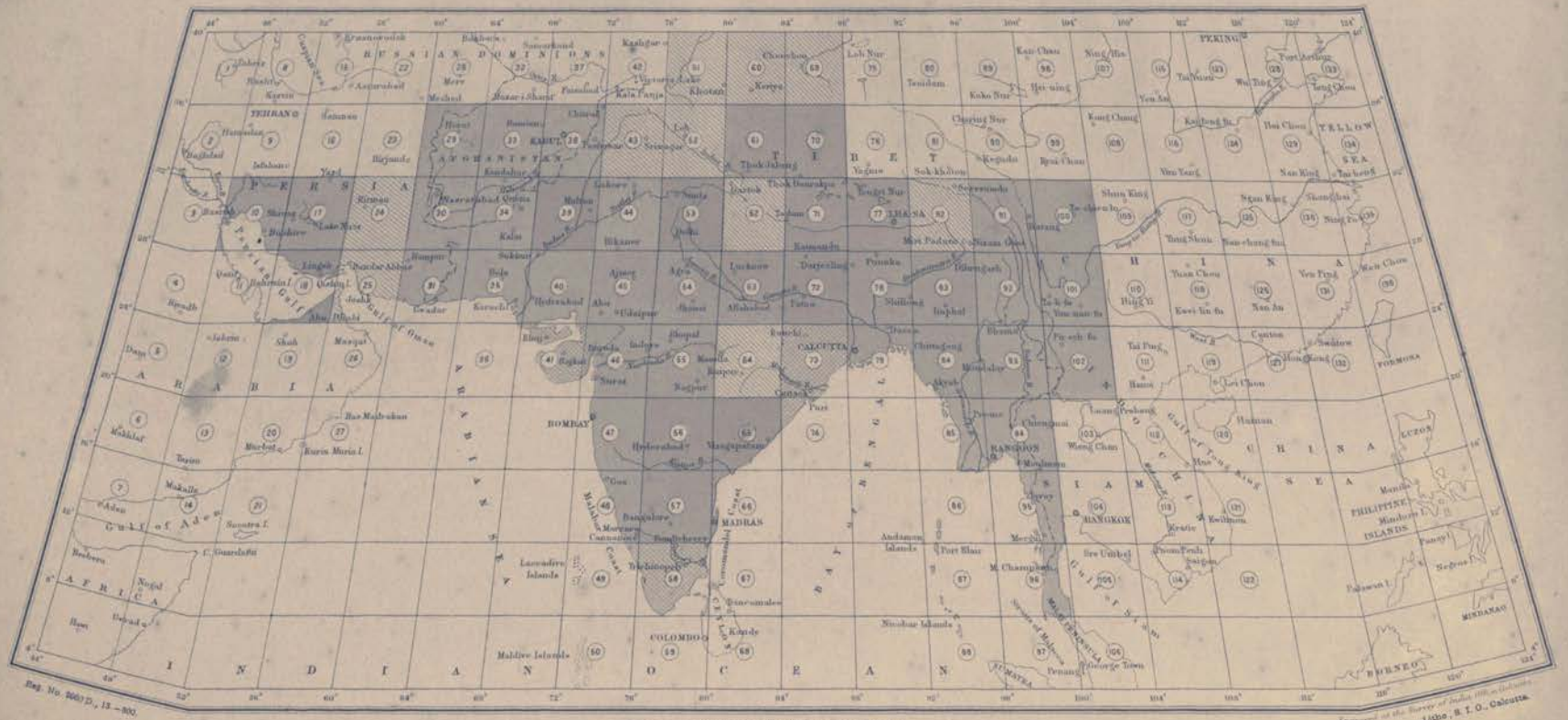


Published under the direction of Colonel Sir S. G. Burrard, K.C.S.I., R.E., F.R.S., Surveyor General of India, 1914.

INDEX TO THE SHEETS OF THE

INDIA AND ADJACENT COUNTRIES SERIES

on the Scale of 1/1,000,000 or 1·014 inches to 16 miles



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1914.

Scale 16 miles to 1 inch

REFERENCE

Sheets published without contours & layers

" " " with contours & layers

" as proofs

" in hand

Engraved at the Survey of India Office, Calcutta.

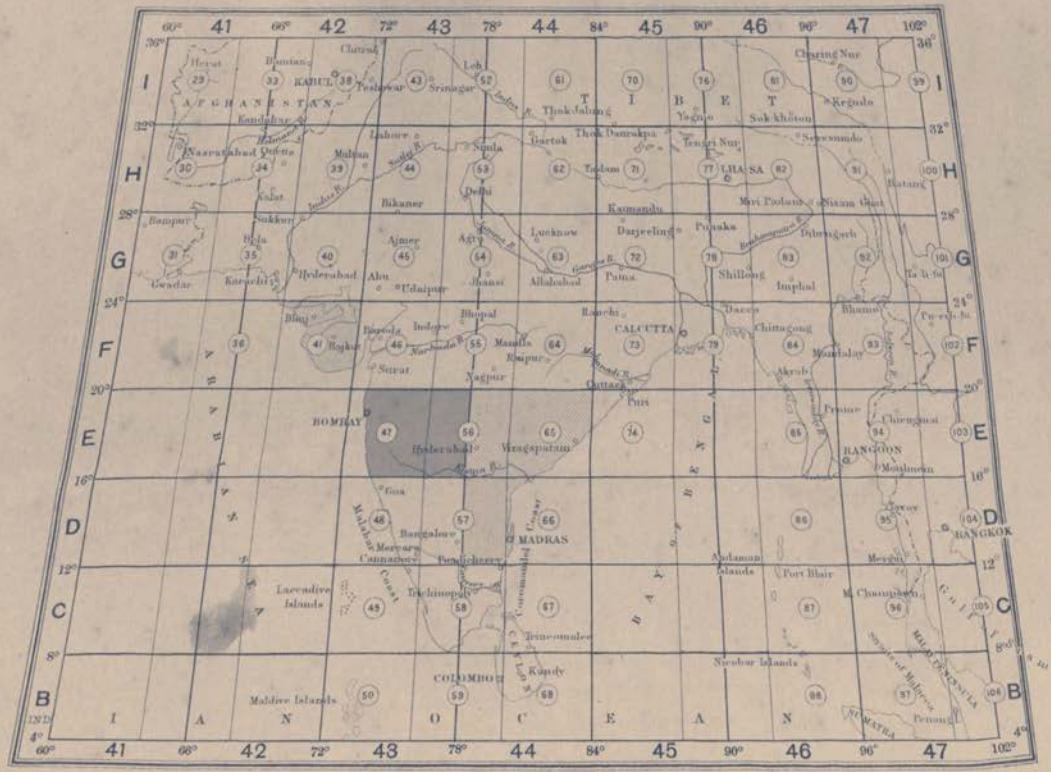
Litho., S.T.O., Calcutta.

10

INDEX TO THE SHEETS OF THE

CARTE INTERNATIONALE DU MONDE

on the Scale of 1:1,000,000.



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1914.

Scale 1/1,000,000.

Miles 200 0 200 400 600 800 Miles

The thick lines show the margins of the sheets of the International Map of the World, Scale 1:1,000,000. Each sheet is designated by the letter N (Northern hemisphere), followed by the marginal letter and number corresponding to its position, *e.g.*, the sheet which includes Bombay is N.E-43.

The figures in circles are the numbers of the sheets of the India and Adjacent Countries Series on the Scale of 1:1,000,000.

REFERENCE.

Sheets published ..... ■

" in hand ..... □

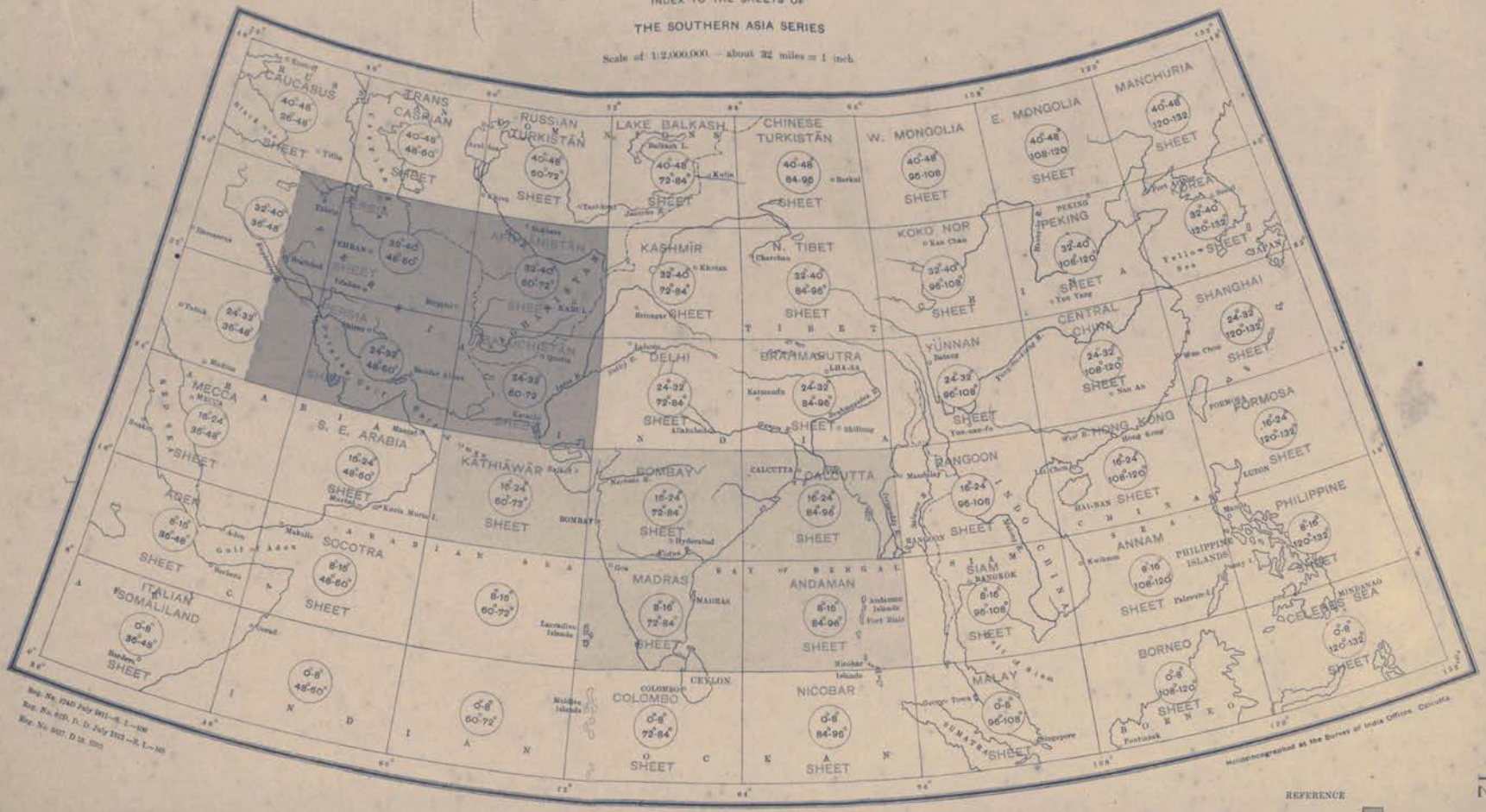
Reg. No. 1485 D.—14.—3250.

Litho., S. I. O., Calcutta.

INDEX TO THE SHEETS OF

THE SOUTHERN ASIA SERIES

Scale of 1:2,000,000. — about 32 miles = 1 inch



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Reg. No. 9027. D 18. 1913

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Scale 1/40,000,000

Miles 200 0 200 400 600 800 1000 Miles

1914

Photozincographed at the Survey of India Offices, Calcutta

REFERENCE

Sheets published

" under publication

" in hand

INDEX CHART
TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA

Survey of India.

GENERAL REPORT,

1914–15.

From 1st October 1914
To 30th September 1915.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

PREPARED UNDER THE DIRECTION OF

COLONEL SIR S. G. BURRARD, K.C.S.I., R.E., F.R.S.,

SURVEYOR GENERAL OF INDIA.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

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CALCUTTA,
1916.

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10. ,, ,, quarter-inch ,, ,,
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12. ,, Indian sheets of "La Carte Internationale du Monde," scale $\frac{1}{1,000,000}$.
13. ,, 'Southern Asia' series, scale $\frac{1}{2,000,000}$.
14. Progress of the Great Trigonometrical Survey.

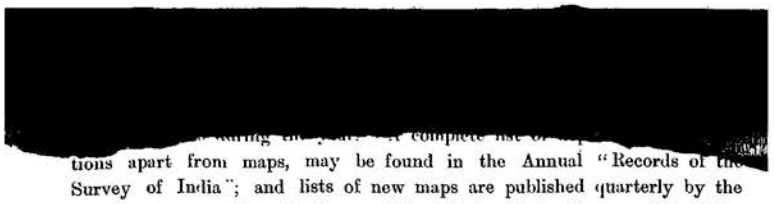
Survey of India.

GENERAL REPORT,
1913—14.

ERRATUM.

Page 15, para. 41, line 5—

For "150 feet to 1-inch" *read* "1,150 inches to one inch".



tions apart from maps, may be found in the Annual "Records of the Survey of India"; and lists of new maps are published quarterly by the department, as well as in the monthly "Notes of the Survey of India".

5. Progress in the Trigonometrical Branch can only be assessed by a study of the "Records of the Survey of India" and the special publications issued at Dehra Dūn. The General Report can attempt little more than a brief abstract of the *locale* and nature of the different operations.

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10. ,, ,, quarter-inch ,, ,,
11. ,, 'India and Adjacent Countries' series, scale $\frac{1}{1,000,000}$.
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14. Progress of the Great Trigonometrical Survey.

Survey of India.

GENERAL REPORT,

1914—15.

From 1st October 1914
To 30th September 1915.

PART 1.—GENERAL REMARKS.

I.—INTRODUCTION.

1. The main parts of this report, as shewn in the "Contents" on the opposite page, are *Part 2—Field Work*, summarising the operations of the field parties, grouped under appropriate headings; and *Part 3—Office Work*, which gives a brief account of the year's progress in the head-quarters and other offices. Fuller details of these operations are being published in Volume IX of the "Records of the Survey of India".

2. An abstract showing the progress of the topographical programme assigned to the department in 1905, may be found in Table II on page 8. From this it will be seen that the out-turn of topographical survey during the current year was 36,676 square miles; and that this brings the total progress since 1905 to 406,491 square miles, leaving 1,415,109 square miles still to be done.

3. The first three Index maps, at the end of the report, show the progress of this topographical programme both in survey and in publication in the three circles, while the remaining eleven indexes show the progress in publication of the various series of maps appertaining to the scheme, and also the main framework of triangulation on which the Survey of India is based.

4. Table IV on page 32 gives a list of the new publications of the Calcutta Offices during the year. A complete list of departmental publications apart from maps, may be found in the Annual "Records of the Survey of India"; and lists of new maps are published quarterly by the department, as well as in the monthly "Notes of the Survey of India".

5. Progress in the Trigonometrical Branch can only be assessed by a study of the "Records of the Survey of India" and the special publications issued at Dehra Dūn. The General Report can attempt little more than a brief abstract of the *locale* and nature of the different operations.

6. Notable Events of the Survey year were as follows:—

(*a*) Owing to the war 33 Imperial Officers have been reverted temporarily to military duty and the services of 19 officers of the Provincial Service have been accepted by the Military Department during the year.

(*b*) Owing to the shortage of officers the field work of the whole department was considerably curtailed.

(*c*) A Survey detachment under an Imperial Officer accompanied the field-force in Mesopotamia and was subsequently reinforced by two more Imperial Officers and four Provincial Officers.

(*d*) The Map Record and Issue Office has been overhauled and it is hoped that the changes introduced will expedite and simplify the business of this office.

(*e*) The Government of India sanctioned in March 1915 the addition of a *new Tactical Map of India on the half-inch scale* to the topographical programme and good progress has already been made in the compilation of this map from available material.

(*f*) *Cavaliere de Filippi's expedition* has been brought to a successful conclusion.

(*g*) The detachment with the *Turco-Persian Frontier Commission* having completed its work returned to India.

II.—ADMINISTRATION AND PERSONNEL.

7. The cost of the department for the financial year ending 31st March 1915 was Rs. 33,84,535 against an estimated cost of Rs. 38,12,550.

8. Colonel Sir S. G. Burrard, K.C.S.I., R.E., F.R.S., administered the department throughout the year, having been granted an extension of service during the period of the war.

9. In the *Imperial Service*, Major F. C. Hirst, I.A., was permanently transferred under the Government of Bengal from 1st February 1914. Lieutenant H. M. McKay, R.E., was killed in action in France on the 13th November 1914. Lieutenant-Colonel R. T. Crichton, C.I.E., I.A., who was on deputation under Bengal reverted to the department from 24th November 1914 and Mr. J. deGraaff Hunter, M.A., who had hitherto held a special appointment was transferred to the cadre of the Imperial Service from 24th January 1915. During the year 33 officers temporarily reverted to military duty on account of the war.

In the *Provincial Service* there were 4 losses: Mr. V. D. B. Collins was killed in action in France, Mr. C. S. Littlewood died, Mr. J. P. Barker retired and Mr. E. J. H. Hanby resigned. Of the seconded officers Messrs. P. Beechy and N. Bedford retired and Messrs. C. A. O'Donel, P. F. Delaney and I. Newton were permanently transferred under the Bengal Government and Mr. O. E. C. Judd under the Assam Administration. Six officers of the Provincial Service were temporarily on deputation to military duty. Three officers received commissions in the Army while on leave in England and 10 officers received commissions in the Indian Army Reserve of Officers.

The total strength of the department at the close of the Survey year was 52 Imperial Officers, 124 Provincial Officers and 41 Upper Subordinates, besides specialists, clerks, lower subordinates and menials; but the number of officers of the first two services actually employed in the department were 19 Imperial Officers and 105 Provincial Officers, the remainder being on military duty.

10. The Computing Office has been made into an executive charge and will take its place amongst the other executive charges of the department.

11. The following Honours were conferred on members of the department during the year:—

To be C.I.E.—	Lieutenant-Colonel C. H. D. Ryder, D.S.O., R.E.
Military Cross.—	Captain F. P. Nosworthy, R.E.
Distinguished Conduct Medal.—	Messrs. E. C. O'Sullivan and A. J. A. Drake.
Silver Medal from the Royal Geographical Society of Italy.—	Major H. Wood, R.E., and Messrs. Jamna Prasad and Shib Lal.

12. The following table shows the distribution of officers during the year; the names of officers absent on long leave throughout the year or on deputation with Local Governments are omitted. Several names occur more than once on account of transfers from one office to another.

TABLE I—DISPOSITION OF OFFICERS, 1914-15.

SURVEYOR GENERAL OF INDIA—Colonel Sir Sidney G. Burrard, K.C.S.I., R.E., F.R.S.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Surveyor General's Office.	Major C. P. Gunter, R.E.			
No. 6 Drawing Office, Simla.	Lieut.-Colonel C. L. Robertson, C.M.G., R.E. Major H. H. Turner, R.E.	Mr. A. B. Hunter ,, A. A. Graham ,, W. H. Strong		*6 European Draftsmen. 25 Indian Draftsmen and Clerks. 4 Printers.
Basrah Survey	Lieut.-Colonel F. W. Pirrie, I.A.			6 Surveyors, &c.

SUPERINTENDENT, MAP PUBLICATION—Major W. M. Coldstream, R.E., up to 23rd September 1915. Lieut.-Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E., from 24th September 1915.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Map Publication Office, Calcutta.		Mr. M. Gastaud		
No. 1 Drawing Office, Map Record and Issue Office and Engraving Office, Calcutta.	Major H. L. Crosthwait, R.E. Captain H. J. Couchman, R.E.	,, T. W. Baboman ,, W. Skilling ,, J. H. S. Wilson ,, P. Williams ,, M. C. Petters ,, Jagdamba Prasad ,, C. C. Byrne ,, A. C. Bose ,, P. Simpson ,, P. N. Sur ,, E. J. H. Hanby		
Photo.-Litho. Office, Calcutta.	Major H. McC. Cowie, R.E. Capt. S. W. S. Hamilton, R.E.			
Mathematical Instrument Office, Calcutta.	Mr. T. A. Ferrier			

SUPERINTENDENT, NORTHERN CIRCLE—Colonel W. J. Bythell, R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 3 Drawing Office, Mussoorie.		Mr. H. W. Biggie ,, J. A. Freeman ,, M. C. Petters		42 Clerks, Surveyors and Draftsmen, &c.
No. 1 Party, *Kashmir.*	Lt.-Col. C. H. D. Ryder, C.I.E., D.S.O., R.E.	Mr. F. M. Powell ,, G. J. S. Rae ,, H. H. B. Hanby ,, M. C. Petters ,, P. A. T. Kenny ,, D. K. Rennick ,, R. C. Hanson ,, W. J. B. Miller ,, E. J. H. Hanby	Mr. Natha Singh, B.S. ,, Nanak Chand Puri, B.A. ,, Hamid Gul	33 Surveyors, &c.
No. 2 Party, *Punjab.*		Mr. B. R. Hughes ,, F. B. Powell ,, Kanak Singh ,, R. E. Saubolle ,, J. H. Johnson ,, J. A. Calvert	Mr. Chuni Lal Kapur ,, Lakshmi Dutt Joshi	40 Surveyors, &c.
No. 3 Party, *United Provinces.*	Captain F. F. Hunter, I.A. Captain F. B. Scott, I.A.	Mr. H. H. B. Hanby ,, E. J. Biggie ,, E. B. West ,, H. T. Hughes ,, G. E. R. Cooper ,, Moqimuddin	Mr. Mahomed Lutf Ali ,, Muhammad Husain	55 Surveyors, &c.
No. 4 Party, *United Provinces.*	Major L. C. Thuillier, I.A. Captain R. Foster, I.A.	Mr. H. W. Biggie ,, E. J. Biggie ,, H. P. D. Morton ,, J. C. C. Lears ,, Dani Chand Puri	Mr. Mohammad Husain Khan	47 Surveyors, &c.
No. 20 Party, *Meerut, Dehra Dun, Saharanpur (Remount Depôt), Hapur, Babugarh (Remount Depôt), Santa Cruz Kalka, Peshawar, Bannu, Jullundur, Landour, Sunawar and Bakloh.*		Mr. A. Ewing ,, F. C. Saint	Mr. Dharma	27 Surveyors, &c.
Riverain Detachment, *Punjab.*		Mr. Maya Das Puri, B.S.	Mr. Paras Ram ,, Vidya Dhor Chopra	83 Surveyors, &c. 9 Naib Tahsildars, Kanungoes, &c.
Simla Survey Detachment, *Simla.*		Mr. C. E. C. French ,, W. H. Strong ,, O. D. Jackson	Mr. Chuni Lal Kapur ,, Paras Ram ,, Imam Din	14 Surveyors, &c.

* Includes Army Section under Major C. J. Arbery.

TABLE I—(Continued).—DISPOSITION OF OFFICERS, 1914-15.

SUPERINTENDENT, SOUTHERN CIRCLE } Colonel T. F. B. Renny-Tailyour, C.S.I., R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 4 Drawing Office, Bangalore.		Mr. J. H. Nichol „ F. P. Walsh „ P. R. Anderson	Mr. B. V. Narayana Rao	39 Draftsmen, &c.
Training Section, Bangalore.		Mr. W. M. Gorman „ S. S. McA'F. Fielding	Mr. Hari Ram Chandra Jogalekar „ E. N. Natesan, B.A. „ Putin Behari Roy „ Jitendra Mohan Mukerji „ J. Sriyati*	15 Pupils. *Under training.* *Resigned 1st June 1915.
No. 5 Party, *Central Provinces and Berar.*	Captain E. C. Baker, R.E. Lieutenant R. S. Wahab, I.A.	Mr. J. O'B. Donaghey „ F. C. Pilcher „ Munshi Lal, B.A. „ C. O. Picard „ A. V. Dickson	Mr. Eknath Battu „ Damodar Kadilkar	32 Surveyors, &c.
No. 6 Party, *Berar, Bombay and Hyderabad.*	Lieut.-Col. F. W. Pirrie, I.A. Major L. C. Thuillier, I.A. Captain K. W. Pye, R.E.	Mr. P. R. Anderson „ E. A. Meyer „ Haji Abdul Rahim, K.S. „ F. B. Kitchen „ R. B. Gildea „ J. C. St. C. Pollett „ K. S. Gopalachari, B.A. „ J. O'C. Fitzpatrick	Mr. Rana Narayan Hastir	33 Surveyors, &c.
No. 7 Party, *Madras, Mysore and Pondicherry.*	Lieut.-Col. F. W. Pirrie, I.A. Captain J. D. Campbell, R.E.	Mr. W. M. Gorman „ C. S. Littlewood (Died 16th August 1915). „ V. W. Morton „ C. West „ H. H. P. Butterfield „ J. C. St. C. Pollett „ N. S. Hariharn Iyer	Mr. Abdul Hakk, K.S. „ Kodandera Mandanna „ H. Narasimhamurti Rao	29 Surveyors, &c.
No. 8 Party, *Madras.*	Major L. C. Thuillier, I.A. Major C. M. Browne, D.S.O., R.E.	Mr. W. F. E. Adams „ S. F. Norman „ J. H. Williams „ P. Kennegy „ M. Mahadeva Mudaliar, M.A.	Mr. Anantarao Bhondiba Mandlire, K.S. „ K. Narayanaswami Chetti „ P. S. Venguswami	36 Surveyors, &c.

SUPERINTENDENT EASTERN CIRCLE— { Lieut.-Colonel C. L. Robertson, C.M.G., R.E., till 23rd November 1914
Lieut.-Colonel R. T. Crichton, C.I.E., I.A., from 24th November 1914.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 5 Drawing Office, Shillong.		Mr. P. J. Barrington „ J. P. Barker, Retired March 2nd, 1915.		22 Surveyors, Draftsmen, &c.
No. 9 Party, *Bengal.*	Lieut.-Colonel C. L. Robertson, C.M.G., R.E.	Mr. J. Smith „ Dhani Ram Verma „ B. C. Newland „ L. B. Fitz-Gibbon „ A. K. Mitra „ V. P. Wainright „ W. P. Hales „ D. N. Banerjee, B.A.	Mr. Dalbir Rai „ Ram Singh.	23 Surveyors, &c., 1 Soldier Surveyor.
No. 10 Party, *Upper Burma.*	Major E. T. Rich, R.E.	Mr. J. Smith „ W. G. Jarbo „ H. B. Simons „ V. W. Morton „ Asmat-Ullah Khan, K.S. „ C. R. Sexton „ A. F. Murphy	Mr. Hayat Muhammad, K.S. „ Maung Kyaw Nyein „ Dhirendra Nath Saha „ Ram Prasad	22 Surveyors, &c., 4 Soldier Surveyors.
No. 11 Party, *Upper Burma.*	Captain L. G. Crosthwait, I.A.	Mr. J. O. Greiff „ Asmat-Ullah Khan, K.S. „ A. M. Talati, L.C.E. „ F. E. R. Calvert „ A. J. Booth „ R. M. Wyatt	Mr. Lachman Daji Jadu, R.B.	32 Surveyors, Draftsmen, &c.
No. 12 Party, *Assam.*	Lieut.-Colonel A. Mears, I.A.	Mr. W. Skilling „ Pramadaranjan Ray, K.S. „ E. M. Kenny „ P. C. Mitra, B.A. „ H. H. Creed	Mr. Nanak Chand Puri, B.A.	35 Surveyors, &c., 7 Soldier Surveyors.
Andamans Detachment.		Mr. E. Claudius		8 Surveyors.

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1914-15.

SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY—Lieut.-Colonel G. P. Lenox-Conyngham, R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates &c.*
Trigonometrical Survey Office, Dehra Dun.	Mr. J. deGraaff Hunter, M.A.	Mr. H. A. Charrier ,, Hanuman Prasad	Mr. Sarat Kumar Mukerji	
Training School *Under training.*	Captain W. E. Perry, R.E.		Mr. Jugal Behari Lal ,, Amir Abdul Sahan Matlub Ahmad ,, Girija Sanker Bagchi ,, Daulat Ram Vohra ,, Amulya Charan Ghosh ,, Ghulam Hasan ,, Ishwar Singh Beri* ,, Jagdeesh Prasad Vastav ,, Manzur Ali Taba Tabace* ,, Gopal Lal Mitra ,, Pratul Chandra Sen Gupta	*Under training.* *Discharged 30th April 1915.
No. 2 Drawing Office and Forest Map Office, Dehra Dun.	Major G. A. Beazeley, R.E.	Mr. J. Smith ,, O. C. Ollenbach ,, H. C. W. Stoteshury ,, O. N. Pushong ,, Abdul Karim ,, O. D. Jackson	Mr. Ram Singh, R.S. ,, Janma Prasad ,, Shib Lal	
No. 13 Party, *(Astronomical).*	*Lieut.-Colonel G. P. Lenox-Conyngham R.E.*			3 Computers, &c.
No. 14 Party, *(Pendulums).*	Major E. A. Tandy, R.E.		Mr. Satish Chandra Mukharji	3 Computers, &c.
No. 15 Party, *(Triangulation).*	Major E. A. Tandy, R.E.	Mr. L. Williams ,, G. A. Norman ,, B. T. Wyatt ,, A. J. Moore		19 Computers, &c.
No. 16 Party, *(Tidal).*		Mr. Syed Aulad Hossein, K.B. ,, Syed Zille Hasnain ,, D. H. Luxa		20 Computers, &c.
No. 17 Party, *(Levelling).*		Mr. H. G. Shaw ,, D. H. Luxa ,, J. McCraken ,, T. F. Kitchen ,, M. S. Ganesa Aiyar ,, Jiya Lal Sahgal ,, N. N. Chuckerbutty	Mr. Karuna Kumar Das, B.A.	11 Computers, &c.
No. 18 Party, *(Magnetic).*		Mr. E. C. J. Bond ,, H. P. D. Morton ,, Rama Prasad Ray, B.A. ,, N. R. Mazumdar ,, Raj Bahadur Mathur, B.A.	Mr. Bidhu Bhusan Shome	18 Recorders, &c.
No. 19 Party, *(Base Line).*	Captain W. E. Perry, R.E.			1 Computer.
Exploration *In Chinese Turkistan with Cav. Filippo de Filippa.*	Major H. Wood, R.E.		Mr. Janma Prasad	1 Surveyor
In Central Asia with Sir Aurel Stein			Mr. Lal Singh, R.B.	1 Surveyor.

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PART 2.—FIELD WORK.

1.—TOPOGRAPHICAL SURVEYS.

13. The two following tables show respectively the progress of the topographical programme assigned to the department in 1905, and the out-turns and costs of different parties during the year under report. They are followed by brief descriptions of the work of each topographical party.

In 1913, the Secretary of State sanctioned a scheme for the reduction of the scale of survey of certain sparsely populated areas of India. This will greatly reduce the area of survey on the one-inch scale and consequently accelerate the rate of progress of topographical surveys shewn in Table II below. In order to give a better idea of what work actually lies before the department, it may be remarked that of the area remaining for survey about 620,000 square miles are likely to be surveyed on the half-inch or smaller scale.

Table II.—Progress of Topographical Surveys since 1905.

Survey year.	Scales of Survey.	Northern Circle.	Southern Circle.	Eastern Circle.	TOTALS.
		Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-06 ...	Mostly 2-inch and 1-inch	6,278	1,660	10,322	18,260
1906-07 ...	ditto ...	7,519	7,666	8,659	23,844
1907-08 ...	ditto ...	14,530	9,256	12,431	36,217
1908-09 ...	ditto ...	18,624	12,526	11,542	42,692
1909-10 ...	Mostly 1-inch ...	23,833	12,532	9,736	46,101
1910-11 ...	ditto ...	27,528	13,171	9,218	49,917
1911-12 ...	ditto ...	23,852	9,115	10,654	43,621
1912-13 ...	Mostly 1-inch and ½-inch	28,192	13,349	11,836	53,377
1913-14 ...	ditto ...	25,052	15,844	14,890	55,786
1914-15 ...	ditto ...	**12,334**	**19,286**	**5,056**	**36,676**
Total Areas completed to date ..		**187,742**	**114,405**	**104,344**	**406,491**
Approximate areas for the whole topographical programme.		**750,000**	**542,800**	**528,800**	**1,821,600**
Approximate areas remaining for survey.		**562,258**	**428,395**	**424,456**	**1,415,109**

NOTE.—The figures of the Northern Circle for the years 1905—07, 1908-09 and 1912—14 have been altered since the publication of the General Report for the year 1913-14.

Table III.—OUT-TURNS and COSTS of Topographical Surveys, 1914-15.

PARTY and LOCALITY. Character of ground.	Scale and type of Survey.	OUT-TURNS. Areas on each Scale.	OUT-TURNS. Totals on all Scales.	TOTAL COSTS. Survey and Mapping.	Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Cost-rates. Rs.*	NORTHERN CIRCLE.
No. 1 Party—*Kashmir.*						
Mountainous and wooded	... 1-inch Survey	2,195	2,445	88,322[2]	36·1	[2] Excludes Rs. 1,739 cost of move to Persio-Baluch Detachment. This Detachment was abolished and no work was done.
Very high Himalayas	... ½-inch Survey	250				
No. 2 Party—*Punjab.*						
Plains, irrigated and non-irrigated	1-inch Survey	844	3,394	71,500	21·1	[3] Includes Rs. 3,984 on account of pay, &c. of Establishment of No. 4 Party employed on ½" mapping in No. 1 Party.
Plains, sand hills and rocky outcrops	1-inch Revision Survey ...	2,550				
No. 3 Party—*United Provinces.*						
Plains and wooded hills	... 1-inch Resurvey	1,359	3,028	85,998 [4]	28·4	[4] Includes Rs. 985,10·8 and 7,849·0·3 cost of work in Kumaun and Ramnagar Forests respectively debitable to the Forest Departments concerned.
Open and wooded plains	... 1-inch Revision Survey ...	1,669				
No. 4 Party—*United Provinces and Nepal.*						
Plains wooded	... 1-inch Resurvey	3,467	3,467	66,354 [5]	19·1	[5] Excludes Rs. 3,084 on account of pay, &c. of establishment employed on ½" mapping in No. 1 Party.
TOTALS, NORTHERN CIRCLE:—		12,334 sq. m.		Rs. 3,12,174	Cost-rate 25·3	
		Sq. miles.		*Rs.*	*Cost-rates. Rs.*	SOUTHERN CIRCLE.
No. 5 Party—*Central Provinces and Berar.*						
Intricate hills, open undulating plateau and cultivated plains.	1-inch Survey	3,070	4,435	79,761	18·0	
Forest-clad hills	... 1-inch Revision Survey ...	1,357				
Ditto	... 2-inch Survey	8				
No. 6 Party—*Berar, Bombay and Hyderabad.*						
Varied, mostly undulating	... ½-inch Survey	5,096	7,640	95,885	12·6	
Intricate hills, rough country	... 1-inch Survey	2,261				
Open plains and undulating	... 1-inch Revision Survey ...	261				
Intricate, with thin forest	... 2-inch Survey	22				
No. 7 Party—*Madras, Mysore and Pondicherry.*						
Rocky hills and cultivated plains	1-inch Survey	2,921	5,423	88,193	16·3	
Undulating plateau	... 1-inch Revision Survey ...	1,929				
Rocky hills, partly wooded	... 1-inch Supplementary Survey ...	134				
Low hills and open plains	... 2-inch Survey	439				
No. 8 Party—*Madras.*						
High forest-clad hills	... 1-inch Survey	1,280	1,788	1,11,521	62·4	
Undulating enclosed coast country	... 1½-inch Survey	508				
TOTALS, SOUTHERN CIRCLE:—		19,286 sq. m.		Rs. 3,75,360	Cost-rate 19·5	
		Sq. miles.		*Rs.*	*Cost-rates. Rs.*	EASTERN CIRCLE.
No. 9 Party—*Bengal.*						No detail survey was undertaken by this party during the year.
No. 10 Party—*Upper Burma.*						
Mostly hilly and thickly wooded	... 1-inch Survey	1,833	2,068	1,24,659 [6]	49·8	[6] Excludes Rs. 30,301, expended on forest boundary surveys, Maymyo Drawing Office and instruction camp for pupils.
Ditto ditto	... 1-inch Revision Survey ...	57				
Ditto ditto	... 2-inch Survey	178				
No. 11 Party—*Upper Burma.*						
Hilly and densely wooded	... 1-inch Revision Survey ...	315	315	5,189	16·4	No. 1-inch mapping was done during the year.
No. 12 Party—*Assam.*						
Open and high grass covered plains and densely wooded hills.	1-inch Survey	1,841	2,448	1,49,231 [7]	57·2	[7] Includes 21 sq. miles special forest survey.
	1-inch Supplementary Survey ...	223				
	2-inch Survey	353 [8]				[8] Excludes Rs. 10,093, for special forest survey debitable to Forest Department.
	4-inch Special Forest Survey ...	31				
Andamans Detachment—*Andaman Islands.*						
Densely wooded hills and mangrove swamps.	2-inch Skeleton Survey (uncontoured.)	225	225	20,927 [9]	93·0	[9] Excluding cost of mapping, to be done by Forest Map Office.
TOTALS, EASTERN CIRCLE:—		5,056 sq. m.		Rs. 2,90,997	Cost-rate 57·5	
GRAND TOTALS:—		36,676 sq. m.		Rs. 9,78,531	Cost-rate 26·6	

NORTHERN CIRCLE (*vide* index map No. 1).

14. No. 1 Party.—The reduced area of survey shown in Table III is due to the curtailment of the winter programme of field work. The Party kept only one detachment in the field which worked during the late autumn and the following summer in the high Himālayas near Kishtwār, and to the North and West of that place in Jammu State, the country varying from 3,000 feet to over 20,000 feet in altitude. Two khalasis lost their lives by accidents in climbing these heights, and difficulties of transport and of weather were considerable.

Triangulation in advance was carried on southwards to the neighbourhood of Dalhousie and is now complete down to the plains of Gurdāspur.

The bulk of the Party remained at Mussoorie throughout the year and a programme of half-inch fair mapping has been commenced by that portion of the Party which did not take the field.

15. No. 2 Party.—This Party surveyed a total area of 3,394 square miles on the 1-inch scale in the districts of Hissār, Karnāl, Rohtak, Delhi, Gurgaon and in the States of Jind, Pataudi and Dujāna. The country surveyed was flat except for occasional sandhills and rocky outcrops; portions only being canal irrigated.

In addition, triangulation and traversing of 1,200 square miles and 284 linear miles respectively were carried out for future half-inch detail survey in parts of Alwar and Bharatpur States.

16. No 3 Party.—This Party surveyed on the 1-inch scale an area of 3,028 square miles, of which 1,359 square miles were re-survey, and 1,669 square miles revision survey.

All the work lay in the United Provinces and embraced parts of the following districts, Bijnor, Sahāranpur, Dehra Dūn, Garhwāl, Muzaffarnagar, Meerut, Naini Tāl, Bareilly, Pilibhīt, and Shāhjahānpur.

With the exception of a small area of the Siwālik hills in Saharanpur and Dehra Dūn districts, and a part of the Kumaun hills, east of the Ganges river facing Hardwār, the country surveyed was flat; forest-clad areas were encountered along the foot hills, also in the Tarāi tahsīl of Naini Tāl district, and in parts of Pilibhīt.

17. No. 4 Party.—This Party surveyed an area of 3,467 square miles of re-survey on the scale of 1 inch to 1 mile in the districts of Bāra Bankī, Fyzābād, Sultānpur, Partābgarh, Jaunpur, Azamgarh and Bastī. The area consists of plains of which the greater portion is highly cultivated and covered with orchards, mango trees being in abundance. It is well-wooded but there is no forest, though scrub jungle occurs in many places. The principal rivers that run through portions of the area that came under survey are the Gogrā and the Gumti.

18. Recess Work.—The whole of the area surveyed this year by the Northern Circle will have been fair-drawn by the parties before they take the field next season.

19. The work of the following party and detachments, also belonging to this Circle, is reported on pages 15 to 17. *No. 20 Party (Cantonment)—Punjab Riverain detachment and Simla Survey detachment.*

SOUTHERN CIRCLE (*vide* index map No. 2).

20. No. 5 Party.—This Party surveyed an area of 4,435 square miles in the Hoshangābād, Nimār, Betūl and Wardhā districts of the Central Provinces and in the Amraotī and Akola districts of Berār, triangulated an area of 3,506 square miles in the Nimār district of the Central Provinces,

in the Buldāna, Amraoti and Akola districts of Berār, in the East Khāndesh district of Bombay and in the Indore State of Central India, and traversed 42 linear miles in the Buldāna and Akola districts of Berār. The nature of the country surveyed varies considerably and consists of forest-clad hills of the Sātpurā and Gāwilgarh ranges, undulating and cultivated portions of the Sātpurā plateau and highly cultivated plains of Berār.

21. No. 6 Party.—This Party surveyed an area of 7,640 square miles in the Buldāna district of Berār, in the East Khāndesh and Ahmadnagar districts of Bombay and in the Aurangābād, Parbhani and Bhīr districts of Hyderābād, and triangulated an area of 7,335 square miles in the Bhīr, Osmānābād, Nānder, Bidar and Nizāmābād (Indūr) districts of Hyderābād. The country surveyed is of a varied nature, consisting to the north of intricate hills and to the south of broad undulating valleys and cultivated lands broken by rocky ridges with occasional high and rocky flat topped hills. More than two-thirds of the area under survey is in Hyderābād and was mostly surveyed on the ½-inch scale.

22. No. 7 Party.—This Party surveyed an area of 5,423 square miles in the North Arcot, South Arcot and Chingleput districts of Madras, in the Kolār, Mysore, Tumkūr and Bangalore districts of Mysore and in the French settlement of Pondicherry, and triangulated an area of 2,309 square miles in the Chittoor, Chingleput, Cuddapah, North Arcot and Nellore districts of Madras. The country consists of forest-clad hills mostly reserved forests, lower rocky hills covered with scrub or devoid of vegetation, open cultivated plains with detached rocky knolls and rocky outcrop and the open undulating plateau land of Mysore.

23. No. 8 Party.—This Party surveyed an area of 1,788 square miles in the Tinnevelly district and the Travancore State of Madras, triangulated an area of 1,360 square miles in the Tinnevelly district, and traversed 144 linear miles in the Travancore State. The country surveyed is very varied in character and extends from the densely inhabited and intricate country along the coast to the high range of mountains separating the Travancore State from the Tinnevelly district, most of the high ground is forest-clad, uninhabited and difficult of access. The survey was laborious and entailed considerable hardships on the members of the party.

24. Recess Work.—The whole of the area surveyed this year by the Southern Circle will have been fair-drawn by the parties before they take the field next season.

EASTERN CIRCLE (*vide* index map No. 3).

25. No. 9 Party.—No. 9 Party traversed an area of 2,870 square miles in the Burdwān, Nadia and Murshidābād districts, in which 1,244 linear miles of theodolite traverse in advance of detailed topographical survey were completed. The country is absolutely flat and thickly populated particularly along the banks of the large streams, but very low-lying and consequently malarious. Communication was easy by means of carts, but some difficulty was experienced in procuring them as the people were not always ready to hire them except at monthly rates. The traversing was based on the stations of the Calcutta Meridional Series of the Great Trigonometrical Survey. No detail survey was undertaken owing to the curtailment of the field programme. The Party with the exception of one traverse camp was consequently employed on half-inch mapping at Shillong.

26. No. 10 Party.—No. 10 Party surveyed an area of 2,068 square miles in the Kathā, Myitkyinā and Putao districts of Upper Burma including 400 square miles of country beyond the Burma-China Frontier and in unadministered territory. 3,320 square miles were triangulated in the Myitkyinā and Putao districts and 164 linear miles of forest boundary surveys were completed. The country surveyed varied from the low lying Kaukkwe valley in the Kathā district which was less than 500 feet above sea level, to the high hills along the Burma-China Frontier, some of which were over 13,000 feet high and covered with snow during the winter months. Both plains and hills were thickly wooded and it was difficult to obtain views of the surrounding country except where ground had been cleared for cultivation.

27. No. 11 Party.—No. 11 Party was employed on half-inch mapping, only a small section of the party was employed in the neighbourhood of Maymyo, on the revision survey, on the 1-inch scale of 315 square miles and on the traversing of 195 linear miles of forest boundaries, for special forest surveys.

28. No. 12 Party.—No. 12 Party surveyed an area of 2,448 square miles on all scales in the Sibsāgar, Darrang, Nowgong and Lakhimpur districts of Assam and carried out 858 linear miles of traversing. Of the above area, 353 square miles comprised a 2-inch scale survey of reserved forests and 31 square miles of special 4-inch forest survey. The country under survey consists partly of the alluvial plains of the Brahmaputra valley and partly of the Mīkīr Hills which rise to an elevation of nearly 4,500 feet and are almost entirely covered with dense forest growth. A considerable portion of the plains is under tea and paddy cultivation interspersed with large tracts of tree and high grass jungle; most of the latter area is flooded during the rainy season and is swampy and much cut up by "bils" and streams.

29. Recess Work.—The whole of the area surveyed this year in this circle will have been fair-drawn by the parties before they take the field next season with the exception of seven sheets of No. 10 Party of which the fair-drawing is well advanced and will be completed later on.

II.—FOREST SURVEYS.

30. During the year 1914-15, the forest surveys have, as usual, been carried out by the topographical parties of the Survey of India. In the majority of cases, the surveys were executed on the scale of 2 inches to the mile but in some few instances, the work was done on the 1-inch scale. A considerable extent of forest boundaries was also surveyed on the scale of 4 inches to the mile.

NORTHERN CIRCLE.

31. No forest surveys were carried out in this Circle during the year under report but certain areas have been traversed and triangulated for a special survey on behalf of the Forest Department, in the Rāmnagar and Nainī Tāl divisions.

SOUTHERN CIRCLE.

32. Central Provinces (*Berār Forest Circle*).—The survey on the 4-inch scale of an area of 3½ square miles which had been left over from the previous programme, in the Dadgaon and Gumi reserves of the Buldāna division, was taken up by No. 6 Party, and in addition, small areas of B and C class forests, aggregating 3 square miles, were surveyed on the 2-inch scale. Theodolite traverses, amounting to 50¾ linear miles, were also run round the boundaries of these blocks and were plotted on the 4-inch scale. These surveys completed the forest areas in the Buldāna division falling within the programme of No. 6 Party.

In the course of its ordinary operations, No. 5 Party surveyed an area of 7½ square miles of Narnāla block in the Akola division on the 2-inch scale. No new theodolite boundary traverses were executed in this division but the survey was carried out by plane-table traverses and interpolation based on points trigonometrically fixed.

33. Madras Presidency.—Ten reserved forests, comprising a total area of 51½ square miles, were surveyed on the 2-inch scale by No. 7 Party during the year. Five of these forests are situated in the North Arcot district and the remainder in the Chingleput district. As a sufficiency of suitable surrounding points was available, the survey was carried out chiefly by interpolation but this had to be supplemented by plane-table traversing in parts; it was found impossible, owing to the flat nature of the country, to fix any conspicuous points. During the progress of survey, all the reserves were checked with the Government notifications and the boundary pillars with their numbers entered where they existed.

34. Bombay Presidency.—In the East Khāndesh district, three forest blocks, comprising an area of 10 square miles, were surveyed by No. 6 Party on the 2-inch scale and their boundaries, amounting to 27 linear miles, were rigorously traversed by theodolite and plotted on the 4-inch scale.

EASTERN CIRCLE.

35. Upper Burma. (*Northern Forest Circle*).—No. 10 Party surveyed the Namkwin, Teinlon and parts of the Nantan and Nanyinkha reserves in the Myitkyinā division, and the Loimaw and parts of the Manmaw, Nanhin, Mawhun and Mohnyin reserves in the Kathā division, amounting to 176 square miles, on the 2-inch scale. In addition to these surveys,

164 linear miles of boundary survey on the 4-inch scale, were completed round the Maingnaung, Nammun, Namma, Nanyinkha and Indawgyi reserves of the Myitkyinā division and round the Nankobin and Namaw reserves of the Mansi division.

Upper Burma. (*Southern Forest Circle*).—No. 11 Party completed theodolite traverses, totalling 195 linear miles, round the boundaries of forest reserves Baw, Baw Extension, Zibingyi-Tonbo, Kywetnapa and Nyaungdauk in the Mandalay Division. The Baw and Baw Extension forest reserves are for special survey, on the 4-inch scale.

36. Assam.—No. 12 Party carried out, in the course of ordinary topograpical operations, the survey on the 2-inch scale, of the Mīkīr Hills, Kalīāni, Panbāri, Upper and Lower Daigurung, Nāmbar (part) and Dayāng (part) reserves embracing an area of 332 square miles. In addition, the balance of the Kāziranga reserved forest, a game sanctuary, was surveyed on the 1-inch scale, the Forest Department being of the opinion that this scale would meet their requirements. The special survey of the Upper Dihing reserve was completed, comprising areas of 21 and 31 square miles, surveyed respectively on the 2-inch and 4-inch scales; the cost of this work has been exclusively borne by the Forest Department.

37. Andaman Islands.—During the year under report, special forest surveys were continued by a detachment consisting of 8 surveyors under the superintendence of a Provincial Officer of the Survey of India and a detailed skeleton survey on the scale of 2 inches = 1 mile, was made of 225 square miles in the island of Baratang and parts of Middle and South Andaman Islands. In addition, 93 linear miles of traversing were run.

III.—CANTONMENT AND LARGE-SCALE SURVEYS.

38. No. 20 Party (Cantonment).—During the year under report, the Party was employed on the survey of Meerut, Dehra Dūn, Landour, Sahāranpur and Hāpur (Bābūgarh) Remount Depôts on scale 16 inches to a mile; and of the bazars of Meerut and Dehra Dūn on scale 64 inches to a mile. The triangulation and traversing of Peshāwar, Jullundur, Bannu, Kālka, Sanāwar, and Bakloh have been completed in advance for season 1915-16. Also during the year Santa Cruz was retraversed to prepare a table of bearings and distances of boundary pillars. A survey of the proposed pipe-line for new Delhi was done for the Military Works Department, and the Guide Map of Mussoorie and Landour brought up to date.

Twenty-one fair maps have been sent for publication, eight fair maps have been completed and are being sent for publication, twenty-four sheets of Meerut are in hand and are nearly completed, and nine sheets of Dehra Dūn and Landour which have just been surveyed will be drawn and sent for publication in March 1916.

The programme for the ensuing year is the survey of Peshāwar, Upper Drosh, Lower Drosh, Chitrāl, Simla Lines, Kālka, Sanāwar, Bakloh, Jullundur, Fort Lockhart, Hangu, Thal and Bannu and the triangulation and traversing in advance of Nimach, Rāwalpindi, Upper and Lower Topa, Jhelum, Siālkot and Chaman.

Out-turn and cost-rates of Cantonment Surveys, 1914-15.

Cantonments.	Scales.	Out-turn Acres.	Total cost.	Cost-rates per acre. Survey and mapping.	Remarks.
			Rs.	*Rs.*	
Meerut, Sahāranpur Remount Depôt, Hāpur (Bābūgarh) Remount Depôt, Landour and Dehra Dūn	... 16″=1 Mile	19,260	41,206·57	2·14	
Meerut and Dehra Dūn	... 64″=1 Mile	318	4,694·82	14·76	Cantonment Bazars.
		19,578	45,901·39		

Alphabetical List of Cantonments surveyed in the new style up to 1914-15.

(1)	Dehra Dūn Cantonment,	Scale 16 inches	= 1 mile.	
(2)	Guna	do.	do.	do.	
(3)	Hāpur Remount Depôt		do.	do.	
(4)	Kamptee Cantonment		do.	do.	
(5)	Landour	do.	do.	do.	
(6)	Meerut	do.	do.	do.	
(7)	Quetta	do.	do.	do.	Surveyed by No. 4 Party.
(8)	Quetta Civil Station		do.	do.	Surveyed by No. 4 Party.
(9)	Rājkot Cantonment		do.	do.	
(10)	Sahāranpur Remount Depôt		do.	do.	
(11)	Saugor Cantonment		do.	do.	

39. Punjab Riverain Detachment.—The detachment continued the work of traversing and laying out bases in the areas under water action of the Sutlej, Rāvi, and Chenāb rivers in the districts of Jullundur, Siālkot and Gujrāt. It also demarcated rectangles with permanent mark stones on the banks of the Chenāb river (districts Gujrāt and Gujrānwāla). These rectangles are to serve as bases for future survey and demarcation of boundaries in the bed of the river. A small area of similar work was also done at the request of the Settlement Officer along the river Rāvi in the Siālkot district. The work has been completed and plotted, and traces are being supplied to the Settlement Officers concerned.

40. *The Kāngra special survey* was started at the end of October 1914 in the Kāngra *tahsil* in continuation of last year's programme under similar conditions as existed during the previous season. In order to reduce the cost no boundaries were enlarged from the topographical maps in the snowy portions and tracts covered with forest reserves, except 2 miles disputed State boundary falling in 3 "*masāvis*" between Chamba and Nūrpur *tahsil*. 3,464 linear and 494 square miles were traversed and triangulated.

41. Under orders of the Punjab Government, the *Simla Settlement Survey* was started early in November 1914 in the Bharauli tract of the Simla district. During January 1915 the Simla Survey proper was commenced, where, in addition to the ordinary work 272 stations (239 boundary pillars and 33 stones) with heights, were picked up for the Simla detachment. After completing the Simla *tahsil* the Kot Khai *tahsil* was taken up during May 1915. As the work here was urgently required by the Settlement authorities it was continued during the whole of summer. In all 1,106 linear and 53 square miles were traversed and triangulated.

42. With a view to prepare a correct map on the same basis as that of the Kāngra Settlement and thus to avoid future boundary disputes, the survey of the *Kāngra trunk road* was undertaken during February 1915 at the request of the Executive Engineer, Provincial Division, Kāngra. Off-sets were taken on traverse lines to various boundary turnings and pillars and after applying the necessary corrections to distances measured along the road, for elevation or depression, the results were plotted on the scale 200 feet to an inch. Portions of the road facing 16 important bazārs were plotted on the scale 50 feet to an inch. The plots were then tested on the ground in various places by the camp officer. Theodolite stations traversed for the Settlement Survey were generally utilized and in addition 418 fresh points covering 34 linear miles were laid out. In all 39 miles of the road were surveyed. Plots were prepared and traces are being submitted to the Executive Engineer.

43. As required by the Deputy Commissioner, Lahore, a small area of 719 acres was traversed and surveyed on the scale 12 inches to a mile to check the boundaries of grass land in the *Lahore Cantonment*.

44. 32 stations covering 29 linear miles were redemarcated in the *Khushāb Thal* (sandy area) at the request of the Settlement Officer, Shāhpur. The cost was debited to the Settlement Officer.

45. Simla Survey Detachment.—The detachment remained at Simla, and continued the survey of the station.

During the year the following work was also undertaken:—surveys of a spur near Sanjauli, an extension of the Simla area, a map of the forest lands in Koti State, and several plans (with information such as, spirit levelled heights, sectional drawings, areas, &c.) required to illustrate proposals for the improvement of the station.

The mapping of 10, out of 31 sheets of the Simla survey, is well advanced. The plans of the Simla extension and Sanjauli-spur will be ready in October.

The Koti State forest map has been sent for publication.

There remains for completion:—(*a*) 2·3 square miles of the Simla survey with the drawing of 21 sheets and (*b*) a proposed plan of 5·3 square miles of country required to illustrate a boundary dispute between Patiāla and Koti States.

It is estimated that these will be completed by March 1916.

IV.—TRIGONOMETRICAL SURVEYS.

GEODETIC OPERATIONS.

46. No. 13 Party.—Astronomical Latitudes.—It had been intended to carry out a series of observations at stations of the Gurwani and Gora Series of the Principal Triangulation, between Latitudes 24° and 27° and on the meridians of 82° and 83° East Longitude. The object of these observations was to amplify our general knowledge of the deflection of the plumb line over the plains of India; there was no special problem in view.

The outbreak of war removed the officer who would have undertaken this work and no astronomical work was done. The establishment of the party was employed at Head Quarters chiefly on the preparation of Triangulation data for publication in pamphlet form.

The marking of the Longitude Stations by means of suitably inscribed slabs was taken up, as it had been found that several of these stations were in danger of being lost sight of.

47. No. 14 Party.—Pendulum Observations.—The programme that it had been intended to carry out comprised:—

(i) Observations at 8 stations in the neighbourhood of Bombay, selected with a view to the further investigation of the large difference between the force of gravity at Colāba and that at Alībāg which had been observed during the season 1913-14.

(ii) Observations at as many stations as possible in the plains of the Punjab, in order to investigate the theory that alluvial deposits depress the denser rocks of the earth's crust on which they rest and so give rise to a diminution in the force of gravity. The low values of gravity in the Ganges Valley have been attributed to this action and it is therefore desirable to ascertain whether similar low values will be obtained in other areas of equal alluvial deposition.

As no officer was available owing to the outbreak of war no observations were made.

The personnel of the party was employed partly at Head Quarters and partly on the delimitation of the boundary between the Pilibhīt district and Nepāl. A report on this work will be found on pages 23 and 24 under the heading "Miscellaneous".

48. No. 15 Party.—Triangulation.—The following series of Principal and Secondary Triangulation were carried out:—

(*a*).—PRINCIPAL TRIANGULATION.

The Chittagong Series.—This is a new Principal Series to connect the Burma Coast Series and the Manipur Meridional Series. It emanates from a side of the former about 30 miles East, North-East of Chittagong and traverses parts of the Chittagong Hill Tracts, the South Lushai Hills and the Chin Hills. Altogether 10 new stations were built, covering about 115 miles of difficult country. The series was satisfactorily laid out but the final connection was not quite completed and an additional station will have to be built to secure this when the observations are taken up.

(*b*).—SECONDARY TRIANGULATION.

Ashta Series.—The connection of this series with the Karāchi Longitudinal Series was completed and proved satisfactory.

Middle Godāvari Series.—This series, which connects the Great Arc and the Jabalpur Meridional Series, was laid out and built in the season 1911-12 under the name of the Bhīr Series. Observations at 18 stations were completed. The connection with the Jabalpur Meridional Series proved very satisfactory.

The Cāchār Series.—This series was designed to connect the Assam Valley Series with the Cāchār Branch of the Eastern Frontier or Shillong Series, and was undertaken at a time when the closing discrepancy of the Nāgā Hills Series and the Manipur Longitudinal Series was believed to be due either to some error or to earthquake movement. Subsequent investigation has shown that the discrepancy is largely due to the fact that the Burma triangulation is unadjusted and is in slightly different terms from the Indian triangulation. The Nāgā Hills Series links these triangulations, and the circuit which it forms has no unduly large closing errors. The final connection with the Assam Valley Series could not be completed owing to unfavourable weather.

The Kohīmā Series.—This series, which connects the Nāgā Hills Series with the Cāchār and Jaintiā Hill Series, was commenced last season when the first six stations were observed. The remaining stations were observed at and the connection completed.

PARTICULARS OF TRIANGULATION DURING 1914-15.

	PRINCIPAL.	SECONDARY.			
	Chittagong.	Ashta.	Middle Godavari.	Cachar.	Kohima.
Number of Stations observed at ...	.....	9	18	12	8
" " newly built ...	10	5	13	10	.....
Length of triangulation completed in miles		39	137	55	67
" " remaining to be done		.....	.....	30	.....
Area of triangulation in square miles ...		426	1,990	747	576
Number of triangles observed ...		7	18	9	9
" Astronomical Azimuths observed		.....	.....	.....	.....
Maximum triangular error	NOT OBSERVED.	3"30	3"67	2"83	3"7
Average " "		2"18	1"25	1"53	1"6
Mean closing error in latitude ...		0"28	0"07	No connection.	0"21
" " longitude ...		0"25	0"10		0"21
" " height ...		2·1 ft.	1·8 ft.		7·7 ft.
" " azimuth ...		4"08	1"6		9"6
" " log side (unit being the seventh place of decimal) ...		246	47		413
Theodolite used		T. & S. 8-inch Mier. No. 1311.	T. & S. 8-inch Mier. No. 1311.	T. & S. 12-inch Mier. No. III.	T. Cooke & Sons, 8-inch Mier. No. 10168

49. No. 16 Party.—Tidal Operations.—Observations were taken by means of self-registering tide-gauges throughout the year, at the stations given in the following list:—

	Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.		REMARKS.
1.	Aden	1879 ...	Still working	36		
2.	Karāchi ...	1868 ...	1880	*13	48	*Small tidegauge working.
		1884 ...	Still working	35		
3.	Bombay (Apollo Bandar)	1878 ...	,,	37		
4.	Bombay (Prince's Dock)	1888 ...	,,	27		
5.	Madras ...	1880 ...	1890	10	30	
		Restarted 1895	Still working	20		
6.	Kidderpore	1881 ...	,,	34		
7.	Rangoon	1880 ...	,,	35		
8.	Moulmein ...	1880 ...	1886	6	12	
		Restarted 1909	Still working	6		
9.	Port Blair	1880 ...	,,	35		

In addition to the above, the actual records of high and low water at Bhaunagar, Akyab and Chittagong were obtained from tide-pole readings taken during day-light by the Port Officers concerned. Tidal diagrams registered by a small river-gauge at Chittagong were supplied by the Port Officer in the earlier part of the year but the record of these diagrams was not found to be wholly satisfactory and hence they were discontinued after May 1914.

All the tidal observatories now working were inspected during the year and the tidal registrations have, on the whole, been satisfactory.

At the request of the Chief Commissioner of Port Blair the tidal observatory at that station has been shifted to a new site about 90 feet towards the south, to meet local requirements.

During the coming year tidal observations will be continued at the nine observatories now working.

50. In the following table are given the annual and decadal percentages of errors in the predicted times and heights of high and low water at all the stations where observations have been taken:—

PERCENTAGE OF ERRORS IN PREDICTED TIMES AND HEIGHTS.

YEAR.	AT OPEN COAST STATIONS.					AT RIVERAIN STATIONS.				
	Number of stations.	IN TIME.		IN HEIGHT.		Number of stations.	IN TIME.		IN HEIGHT.	
		Within 15 minutes of actuals.		Within 8 inches of actuals.	Within $\frac{1}{10}$ of mean range at springs.		Within 15 minutes of actuals.		Within 8 inches of actuals.	Within $\frac{1}{10}$ of mean range at springs.
		H.W.—L.W.		H.W.—L.W.	H.W.—L.W.		H.W.—L.W.		H.W.—L.W.	H.W.—L.W.
1905	7	82	79	96 95	96 97	2	52	62	72 57	94 92
1906	6	85	81	96 97	94 95	2	59	53	74 64	92 95
1907	6	84	83	98 98	98 99	2	58	47	78 60	96 90
1908	6	84	84	98 97	99 99	2	58	52	77 60	97 92
1909	6	85	86	97 97	97 98	3	61	59	69 65	93 92
1910	6	81	83	98 98	95 96	3	57	52	63 71	89 94
1911	6	84	84	98 99	97 98	3	65	51	68 66	90 90
1912	6	82	82	97 98	97 98	4	70	58	74 62	94 91
1913	6	83	82	97 97	98 99	4	68	55	70 58	94 88
1914	6	77	79	96 97	98 98	3	75	66	71 55	92 84
Average of ten years	...	83	82	97 97	97 98	...	62	56	72 62	93 91

51. No. 17 Party.—Levelling.—Three detachments were employed on the new system of "fore and back double levelling" during the past season.

52. *No. 1 Levelling Detachment* was employed (*a*) on *new levelling* from Bareilly to Hāthras along the road, (*b*) on *new levelling* from Multān to Bahāwalpur by road, (*c*) on a *revision* of the old line Meerut-Morādābād-Bareilly along the main road.

The outturn amounted to 342 miles. The heights of 3 Principal Stations of the Great Trigonometrical Survey, and of 474 Secondary Bench-marks were determined.

(*a*) The line Bareilly-Hāthras completes the circuits:—

(*i*) Bareilly-Hāthras-Meerut-Bareilly, 346 miles in length, closing with an error of −0·064 of a foot.

(*ii*) Bareilly-Hāthras-Agra-Cawnpore-Lucknow-Bareilly; 513 miles in length, closing with an error of +0·202 of a foot.

(*b*) The line Multān-Bahāwalpur completes the circuits:—

(*i*) Multān-Bahāwalpur-Ferozepore-Lahore-Sargodha-Multān; 299 miles in length.

(*ii*) Multān-Bahāwalpur-Murghai-Khemwālā-Multān; 640 miles in length.

The closing errors were respectively −0·309 and +0·195 of a foot.

53. *No. 2 Levelling Detachment* was employed on *new levelling* from Benares to Barākar along the Grand Trunk Road (part of the Benares-Howrah line), with branch lines from Barūn to Belsar along the Patna Canal, and from Bankipore to Bihta.

The outturn amounted to 352 miles. The heights of 4 Primary and 325 Secondary Bench-marks were determined, including 2 Principal Stations of the Great Trigonometrical Survey.

54. *No. 3 Levelling Detachment* was employed (*a*) on a *revision* of the line from Bellary to Gooty by road, (*b*) on *new levelling* from Raichūr to Bāgalkot by road, (*c*) on *new levelling* from Bāgalkot to Bijāpur along the main road.

(*b*) The line Raichūr to Bāgalkot closes the circuit Raichūr-Bāgalkot-Belgaum-Hubli-Bellary-Guntakal-Raichūr, 519 miles in length, with a closing error of +0·620 of a foot.

The outturn amounted to 253 miles. The heights of 8 Primary and 155 Secondary Bench-marks were determined.

55. In addition to the above about 50 miles of single levelling were carried out in the *Island of Bombay*, at the request of the Local Government in order to provide heights of sufficient bench-marks for the control of the large scale survey of the Island which is still in progress.

56. No. 19 Party.—Base Line Operations.—During the year under report electric power became available in Dehra Dūn and the wiring of the Comparator rooms was done. The public supply is a three-phase alternating current at 380 Volts pressure, as a continuous current at 100 Volts is necessary for the motors, heater, &c. of the comparators, a motor generator was erected to effect the transformation. The comparators are now ready but owing to the diminution of the strength of the department in consequence of the reversion of so many officers to military duty there is no present prospect of any Base Line work being undertaken.

MAGNETIC SURVEY.

57. No. 18 Party.—Magnetic.—Two detachments were employed throughout the field season, and a third detachment was sent out towards the end of the season for two months to assist in completing the season's programme which comprised observations to determine the values of the magnetic elements at 73 repeat stations in India and Burma, as well as the inspection of three magnetic observatories and observations for the comparison of the instruments at each of the observatories.

On the recommendation of the Committee presided over by Dr. G. T. Walker, which was appointed in 1914 to discuss the position of the magnetic survey, the repeat stations were marked this season in a permanent manner by suitable concrete pillars and were handed over for preservation to the care of the local authorities, so that there should be no doubt in future as to their exact position. These stations will henceforward be visited at intervals of about 5 years, for the accurate determination of the secular changes of the magnetic elements.

The officer in charge was employed during the field season, with the assistance of the Head Quarters staff of the party, in carrying on the work of the final reduction of the field observations of Horizontal Force to the selected epoch, and in the revision of the preliminary values of Declination from the additional data accumulated during the past few years.

58. The Magnetic Observatory at Barrackpore was closed on the 26th of April. This observatory was built in July 1903. Self recording instruments showing the Declination and the Intensity of the Horizontal Force were installed in August of the same year, and one for recording the Vertical Force in April 1907. These instruments have been in operation up to the 25th of April 1915.

Dr. Walker's Committee came to the conclusion that the four observatories at Dehra Dūn, Alībāg, Kodaikānal and Toungoo were sufficient for recording the course of terrestrial magnetism in India, and recommended that the Barrackpore observatory should be closed as soon as a complete set of permanently marked field stations, scattered over the country, had been established and observations at all of them had been made. These observations, at the 73 repeat stations alluded to above, were finished at the end of April 1915 and the observatory has accordingly been closed.

59. *Work during recess season.*—The computation of the field observations of 1914-15 and the reduction and tabulation of the magnetic elements for the four survey base stations (Dehra Dūn, Barrackpore, Kodaikānal and Toungoo) for 1914 have been completed; the mean values of these elements for the year 1914 derived from all days, excluding those of great disturbances, are given in the table below.

The reduction of the field observations of Horizontal Force and Declination to the selected epoch is in progress.

Mean values of the Magnetic Elements at Observatories in 1914.

Observatory.	Latitude & Longitude.	Dip.	Declination.	Horizontal Force.	Vertical Force.
	° ′ ″	° ′	° ′	C. G. S.	C. G. S.
Dehra Dūn ...	30 19 19 N 78 3 19 E	N 44 22·9	E 2 18·8	0·33165	0·32458
Barrackpore ...	22 46 29 N 88 21 39 E	N 30 58·9	E 0 32·2	0·37403	0·22459
Toungoo ...	18 55 45 N 96 27 3 E	N 23 6·1	E 0 2·6	0·38983	0·16628
Kodaikānal ...	10 13 50 N 77 27 46 E	N 4 11·2	W 1 17·1	0·37571	0·02750

V.—GEOGRAPHICAL SURVEYS & EXPLORATION.

60. Cavaliere de Filippi's Expedition to the Karakoram.—The expedition brought its operations to a close in the autumn of 1914. Major Wood went to Europe with Cav. de Fillippi and reached Rome in December 1914. The two surveyors with the expedition did not accompany it beyond Kashgar, but spent the winter partly in Kashgar and partly in Yārkand and returned to India *viâ* Gilgit in the spring of 1915.

The computations of the observations and the drawing of maps is being carried out at Dehra Dūn. A preliminary rough map was prepared by Major Wood while in Rome and a photograph of this has been received in Dehra Dūn. A general description and map of the expedition may be found in the "Geographical Journal" for August 1915. It embraces an area of 9,100 square miles on the quarter-inch scale.

61. Sir Aurel Stein's Archæological Expedition in Central Asia.—The expedition after a very extensive tour reached Kaśhgar in June. The two surveyors lent by the Survey of India, Rai Bahadur Lal Singh and Muhammad Yakub Khan, were to return thence to India as soon as the work of making traces and copies, as a security against accidental loss, had been completed. They had not reached India at the close of the year under report. The total area of survey completed by the surveyors under Sir Aurel Stein during the several years he has been exploring in Central Asia now amounts to about 150,000 square miles on the quarter-inch scale.

62. Turco-Persian Frontier Commission.—A detachment under Lieut.-Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E., accompanied this Frontier Commission, which worked from the head of the Persian Gulf to Mount Ararat. Triangulation was carried out by Major H. M. Cowie, R.E., over the greater part of the frontier, an area of 7,500 square miles being surveyed by the detachment, and 227 pillars erected. Fair maps, 35 in number, comprising nearly the whole frontier 1,180 miles in length, have been published. The whole frontier was demarcated except a small portion near Kotour; work commenced in December 1913 and closed in October 1914.

VI.—MISCELLANEOUS.

63. Boundary between Nepāl and the United Provinces.—At the request of the Government of the United Provinces the work of laying out the boundary between Nepāl and the Pilībhīt district was undertaken. Major E. A. Tandy, R.E., was in charge of the work and had under him a detachment made up from several field parties.

The simplification of the existing boundary, so as to convert it into a line consisting of a series of straight links, except where it follows some definite and permanent natural feature, was a matter of some difficulty; an alignment was, however, finally discovered which was accepted as equitable by both sides, and a careful traverse was then executed which puts on permanent record the position of the pillars which define the straight links.

This part of the boundary has long been a source of trouble as disputes with regard to its position have frequently arisen and have been difficult to settle. The new demarcation will, it is hoped, put an end to this state of things.

In 1912-13 the boundary between Nepāl and the Naini Tāl district was demarcated, so that now the whole of the old boundary line along the Sārdā river, which had given so much trouble, has been revised and improved.

PART 3.—OFFICE WORK.

I.—HEAD QUARTER OFFICES.

MAP PUBLICATION OFFICE (*vide* Index maps at end).

64. The classes of maps for the publication of which the Head Quarter Offices are responsible, may be enumerated as follows :—

(*a*)—Topographical maps on the scale of 1 inch to 1 mile.
(*b*)—Topographical maps on the scale of ½ inch to 1 mile.
(*c*)—Topographical maps on the scale of ¼ inch to 1 mile.
(*d*)—Geographical maps on the one-millionth scale (about 1 inch to 16 miles).
(*e*)—Geographical maps on the two-millionth scale (about 1 inch to 32 miles).
(*f*)—General maps on small scales.
(*g*)—Special maps.

The first duty of the offices is to publish the one-inch, half-inch and quarter-inch maps prepared by the field parties and Circle drawing offices from the results of the topographical surveys now in progress.

65. *(a)* **Topographical maps on the scale of 1 inch to 1 mile.**—During the year 207 sheets have been received for publication and 154 have been published. The corresponding figures for the previous year were 176 and 158 respectively. The output would have been larger if the machines had not been so fully occupied in complying with military requirements.

Putting aside the sheets surveyed in Kashmīr where the season of field survey differed from that in other parts of India, the one-inch maps of all areas surveyed up to 30th September 1913 have been published with the exception of 2 sheets. Of the sheets surveyed up to 30th September 1914 very few have been published.

Index maps Nos. 4—6 at the end of this report show the progress made in the publication of the modern one-inch sheets and the table below gives the annual output of sheets since the modern topographical surveys were begun :—

Year.	Number of 1-inch Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1905-06	...	...	...	...
1906-07	4	1	...	5
1907-08	16	15	22	53
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
1911-12	68	33	58	159
1912-13	104	60	58	222
1913-14	71	38	49	158
1914-15	**97**	**48**	**9**	**154**
Total Published ...	518	314	358	1,190
Approximate number of 1-inch sheets in India ...	2,160	2,067	2,101	6,328
Approximate number remaining for publication.*	1,642	1,753	1,743	5,138

* These figures include a large number of sheets, about 2,400, in deserts, at high altitudes and in other thinly populated tracts of which maps on so large a scale as 1 inch to the mile are unlikely to be required.

The general style of the one-inch maps is unchanged, but as opportunity arises owing to printing of new editions, sheets thus republished are hill shaded.

In addition to the output of modern one-inch sheets mentioned above, 42 sheets prepared from modern revenue surveys have been received for publication, and 55 published as preliminary editions pending their topographical revision at some future date (*vide* Index maps No. 7 and No. 8); 62 special editions of modern one-inch sheets have been published at the request of Local Governments to show village boundaries.

To maintain stocks or to give effect to important changes due to the development of communications, 12 modern one-inch sheets and 47 old style sheets on various scales have been reprinted.

66. *(b)* **Topographical Maps on the scale of ½ inch to 1 mile.** (*Vide* Index map No. 9).—In addition to the areas which are being surveyed and mapped on the ½-inch scale, of which one sheet has been published, it has been decided to publish half-inch maps of all those areas already published on the 1-inch scale. Sixteen such sheets have been received for publication but none have so far been published. When a new style of map is commenced there are inevitable delays before the work gets well started but a large outturn in the publication of these sheets is expected in 1915-16.

67. *(c)* **The map of India on the scale of ¼ inch to 1 mile.** (*Vide* Index map No. 10).—This map is prepared in "degree sheets" which include 1°×1°, or the area covered by 16 one-inch sheets.

The following table shows the progress made in publication:—

Years of Publication.	Number of Degree Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1911-12	2	1	4	7
1912-13	3	1	1	5
1913-14	4	3	2	9
1914-15	**1**	**3**	**3**	**7**
Totals	10	8	7	25
Approximate number of degree sheets in India	170	140	140	450

Note.—The figures for 1911-12 do not agree with those in previous reports owing to the inclusion of three sheets previously classified as "Provisional."

Pending the preparation of the new degree sheets from modern surveys, 46 degree sheets have been published during the year as Provisional Issues; these have been prepared from the maps of old surveys and have therefore not been included in Index map No. 10. 137 Atlas sheets and 17 District maps on the same scale (½-inch to 1 mile) have been reprinted.

68. *(d)* **Geographical Maps on the one-millionth scale,** (about 16 miles to 1 inch). (*Vide* Index map No. 11).—During the year 5 sheets of this series were published and the remainder should be completed in about two years. All the sheets published this year are contoured and printed with hypsometrical layers, the colouring used differing somewhat from that on the "International Series", with more satisfactory results.

The engraving of several of these sheets is in hand, but reproduction by heliozincography has of late years so much improved that it is doubtful whether, except in the lettering, the engraved maps are sufficiently superior to justify the time and expense spent in engraving them.

The publication of the hêliozincographed edition of sheet 47 is of special interest as it covers the same ground as International Series, No. 43-E and a comparison can be made of the relative advantages of the two series.

69. La Carte Internationale du Monde au 1,000,000:—(*Vide* Index map No. 12). A full description of the genesis of this series was given in the General Report for 1913-14.

No sheets have been published this year, but two are at press and several in an advanced stage.

Owing to the war, no further meetings of the International Committee have been held.

70. *(e)* **Geographical Maps on the two-millionth scales** (about 32 miles to 1 inch). (*Vide* Index map No. 13).—No further sheets of this series were published during the year but two are at press and the drawing of two others well in hand.

71. *(f)* **General Maps on small scales.**—The Political Edition of the Map of India and Adjacent Countries, scale 32 miles to 1 inch, in 12 sheets, is at press and will shortly be published; the layered editions of this map having been published last year.

The annual edition of the Railway Administration Map of India, scale 64 miles to one inch, shewing information up to the 30th June 1915 was published in August.

72. *(g)* **Special maps.**—Many special maps, &c., have been prepared for the various departments of Governments, both Local and Imperial, and for the General Staff including maps for Artillery Practice Camps.

73. During the year the *machine presses* in the Photo.-Litho. Office were employed in the following proportion, 44 departmental, 34% extra-departmental and 22% for the Military Department.

74. The total number of maps issued during the year shows a large increase with a small increase in the total value.

75. Map Record and Issue Office.—During the past year the face value of maps received from the various printing offices amounted to Rs. 3,82,246, of this sum Rs. 14,083 represents the value of maps printed in the Engraving Office, and Rs. 53,033 of those which were received from the Dehra Dûn Offices.

Details of the numbers and classes of maps published during the year and their value is given in Table IV on page 32.

The total number of maps issued from the Office during the year was 425,008 of an aggregate value of Rs. 1,78,958.

The details are as follows:—

	Government Officials.	*India Office.*	*Departmental Issues.*	*Private Individuals.*	*Map Agents.*	**Totals for 1914-15.**	*Totals for 1913-14.*
No. of maps	303,689	3,950	88,937	24,073	4,368	**425,008**	359,917
Value Rs.	95,600	5,257	53,382	19,309	5,410	**1,78,958**	1,77,546

76. No. 1 (Head Quarter) Drawing Office. The office was employed in the compilation and drawing of the helio editions of maps of India and Adjacent Countries. Four sheets on the one-millionth scale were completed during the year and five are in hand. Two sheets of the Southern Asia Series, two-millionth scale, were sent to press, while two other sheets are well advanced.

During the year under report seven patterns were prepared for the engraved edition of the one-millionth India and Adjacent Countries Series and three for the one-millionth International Series. The compilation of material to be utilized for an engraved map of India on the four-millionth scale which will embrace the area covered by the 32-mile map of India, is in progress.

Fifty-four sheets on various scales were stump-shaded during the year.

A *special map of West Germany* in two sheets on the scale of 1 inch to 6 miles was prepared. These two sheets were later reduced by photography to a scale of 1 inch to 8 miles and have been published as one sheet.

Two maps of *the new half-inch series* were completed during the year; of nine others in various stages of completion four are expected to be sent to press by December 1915.

The *Mapping and Reprint Sections* prepared 33 quarter-inch (degree) sheets based on old Atlas sheets. These degree sheets are classed as "Provisional Issues" and printed in black. They have been brought up to date as regards railways and roads from material supplied from extra-departmental sources. They will be superseded eventually by modern degree sheets in colours when the areas comprising them came under revision survey. The originals of sixty-three maps on various scales have been corrected and brought up to date to supply reprints. In addition a large number of maps drawn in circle offices and field parties have passed through the section for minor corrections.

Under the head of *Extra-departmental work* which was undertaken may be mentioned the Bassein and Henzada maps for district gazetteers, Postal maps of Bengal and Assam and Bihār and Orissa, Telegraph and Railway maps for India and a special manœuvre map of Chotā Nāgpur.

The primary duty of the *Office Copy Section* is to maintain a complete record of all alterations and additions to published maps which may be brought to notice. In addition to miscellaneous work on a large number of sheets, new canals, railways, main roads and changes of boundaries *notified by district authorities* were inserted on 2,187 maps.

77. Engraving Office.—During the year the engraving of five sheets for four-colour printing of the one-millionth India and Adjacent Countries series was completed; also 1 Degree sheet together with 1 International map were finished. Two one-millionth and 2 International maps are almost ready for press.

Eleven new maps were taken in hand and are now in various stages, namely, 4 one-millionth sheets, 6 International maps and 1 Degree sheet. The engraving of the new four-millionth map of India, which is to replace the present 64-mile map has also been begun. The system now adopted is to engrave a separate plate for each colour which, when proper precautions are taken, gives remarkably good registration results.

The periodic correction of the plates of engraved maps has been continued. In this connection it was found necessary to completely re-engrave a considerable area on the 32-mile map of India north of Sadiyā where recent explorations had brought to light large changes in the course of the Brahmaputra and the drainage system connected with it. A new feature of the 5th edition of this map, now under publication, will be the approximate indication of the area under perpetual snow in the Himālayas and Tibet.

During the year a considerable number of Commission Forms and Certificates have been engraved and printed in colours for the Army Department.

Among the miscellaneous work carried out may be mentioned the engraving and printing of different kinds of section paper for statistical purposes, scales of various kinds and dies for the ornamentation of maps.

In the *Copper-plate-printing section* of this Office 30,872 impressions were pulled. Of these 9,002 were for extra-departmental orders, 1,475 Commission Forms and 7,547 photogravure prints.

Two new motor driven printing presses were installed during the year, one of which is specially suitable for printing photogravures. In the *Electro-typing and steel facing Section* 370 plates were treated.

78. Photo.-Litho. Office.—At the commencement of the Survey year there were seven machine and fourteen hand presses in use. These were supplemented by an eighth machine press, a Double Demy, in April, 1915 and by a ninth, a Quad Crown, in June. Both these new machines were supplied by Messrs. Mann & Co. Amongst the older machines were two which were incapable of giving consistently precise registration and were not very suitable for work involving more than one colour or printing. It was to make good the weakness of the machine room in this respect that the new machines were obtained.

Except for short periods of a few days, when first one and, later, a second machine were forced to be idle on account of motor defects, all the presses were run continuously during the year.

The *Litho. Branch* of the Office has, so far, been but little affected by war conditions.

In the *Photo. Branch* no change of material has occured during the year. The most important modification of procedure, rendered necessary by the war, has been the substitution of pyroxilin collodion for the celloidin-pyroxilin collodion used formerly. Some difficulty was experienced, at first, in reducing to a reasonable figure the percentage of waste products, when making up the pyroxilin collodion. Success in this respect was, however, soon attained and no troubles resulted from this change of collodion which was introduced at the beginning of June 1915.

Though the office has had to undertake a large amount of printing for the General Staff and has not, at the same time, made corresponding decreases in the quantity of other extra-departmental work accepted for reproduction, the outturn in departmental maps has been, thanks to the increase of machine power, higher than in either of the two preceding years. Column 5 of Table A, gives the actual figures for the three years.

Both departmental and extra-departmental work being taken into account, the total number of impressions pulled in the litho. machine presses was 1,987,591 producing 730,917 finished copies. The figures just given do not include the number of proof impressions pulled in the hand presses nor the sheets of paper polished in the machines before printing.

The total number of impressions pulled in machine presses and hand presses together is, as will be seen in Table B, column 2, rather lower than that of last year. This is due to the fact that for a great deal of the work for the General Staff and for reprints the printing orders have been small, so that the time spent in making machine preparations, preliminary to printing, stands in high proportion to that occupied by actu printing.

During the year, 154 new modern style *one-inch standard sheets* in colours were published and 12 were reprinted. Of the provisional edition, 8 sheets were printed in black and brown and 47 in black only. The total number of one-inch sheets printed during the year is, thus, 209.

Of quarter-inch maps in colours, 18 new *degree sheets* were published while 85 were reprinted either in colour or in black only.

Seven new *one-millionth sheets* were published in colours and 3 reprinted.

The *Photo. Branch* has received, during the year, the originals of 327 and the colour patterns of 241 maps to be printed in colours.

The Negative Section has dealt with 4,435 negatives and the Retouching Section with 4,711. These figures show increases of 888 and 1,008 over those of the preceding year.

The Helio and Vandyke Sections turned out 6,736 plates, 1,716 more than in 1913-14.

The Process Engraving Section pulled 65,732 half-tone impressions, of which 11,250 were from departmental blocks. From line blocks prepared by the section 1,491,403 impressions were pulled, only 400 of which were for the department. These figures are higher than those of 1913-14 by 30,022 in the case of half-tone impressions and by 616,403 in that of those from line blocks.

Out-turn of Photo.-Litho. Office during 1914-15.

TABLE A.

1	2	3	4	5	6	7
Year.	Cost of office.	Value of out-turn at cost-rates.	Recovered in cash or by book-debit.	Number of maps printed.		
				Departmental.	Other than Departmental.	Total.
	Rs.	*Rs.*	*Rs.*			
1912-13	1,64,699	2,39,940	27,214	574	1,999	2,573
1913-14	1,67,801	2,40,721	33,468	491	1,975	2,466
1914-15	**1,55,515**	**2,81,146**	**36,847**	**597**	**2,168**	**2,765**

TABLE B.

1	2	3	4	5	6	7
Year.	Number of impressions pulled in Litho. Branch.	Number of half-tone impressions pulled.	Number of line-block impressions pulled.	Type Section Outturn.		
				Pages or items published.	Copies printed.	Impressions pulled.
1912-13	1,966,458	51,370	530,280	8,408	1,343,465	2,608,591
1913-14	2,286,845	35,710	875,000	6,403	1,203,242	2,132,159
1914-15	**2,100,103**	**65,732**	**1,491,403**	**5,987**	**1,317,298**	**2,122,811**

The figures for 1912-13 and 1913-14 in columns 5, 6 and 7 of the Table A above, differ from those given in the General Report for 1913-14 as, this year, account has been taken only of finished maps received from the machines. In former years, proofs and blue prints turned out by hand presses were included.

79. Mathematical Instrument Office.—During the year from 1st April 1914 to 31st March 1915, there was a continued increase in the demands made on this office (*vide* item No. 1 in para. 2) as well as in the value of work done (*vide* item No. 2 in para. 2), and there was respectively a profit of Rs. 38,366, and Rs. 22,012, against Rs. 33,571 and Rs. 10,346 in the year 1913-14.

2. Below are given the usual comparative figures for the last 3 years :—

	1912-13.	1913-14.	1914-15.
	Rs.	*Rs.*	**Rs.**
1. Total issues to Public Offices as shown in the Profit and Loss statements of stores.	2,81,315	4,07,802	**4,16,642**
2. Value of repairs to instruments received for repairs and returned in a serviceable condition.	64,452	56,418	**66,793**
3. Value of instruments received from Government Officers when no longer required.	37,267	69,806	**50,924**
4. Book value of the stock of instruments, &c., in Serviceable Stores.	6,45,081	4,73,470	**5,06,865**
5. Book value of the stock of instruments, &c., in Repairable Stores.	72,452	67,299	**62,347**
6. Total value of work done in the Workshop ...	2,15,328	2,40,752	**2,44,054**
7. Value of instruments manufactured in the Workshop for Serviceable Stores.	71,188	93,991	**87,421**
8. Value of instruments purchased locally ...	6,206	9,060	**9,792**
9. Value of instruments and materials obtained from England through the Director General of Stores.	57,647	89,213	**2,78,380**
10. Average No. of employés and their pay ...	No. 301 Rs. 68,625	No. 300 Rs. 76,734	**No. 317 Rs. 80,917**

3. During the year the stock of all the three stores, (the Serviceable, the Repairable and the Material Stores), was twice taken and the discrepancies noticed have been adjusted.

Table IV.—Departmental Publications, Calcutta, 1914-15.

Note.—For special publications at Dehra Dun, *vide*, pages 34 to 37.

Class of Maps.	Scale.	Number of different maps of each class received.		Number of copies printed.	Value.
		New Publications.	New Editions and Reprints.		
GEOGRAPHICAL MAPS.					*Rs.*
Maps of India	Various	.....	1	2,706	4,059
Southern Asia Series	1:2,000,000	.....	..	... ..	....
India and Adjacent Countries ...	1:1,000,000	2	11	8,476	8,476
Do. (International Series) ...	1:1,000,000	... ..	... .	.....	.....
TOPOGRAPHICAL MAPS.					
DEGREE SHEET SERIES.					
Modern	1"-4 miles	39	57	94,809	93,284
Preliminary and Provisional ...	Do.	.....	... ..	..	.....
From Atlas Material	Do.	46	39	18,641	18,641
HALF-INCH SERIES.					
Modern	1 -2 miles	1	.....	490	490
ONE-INCH SERIES.					
Modern	1"-1 mile	154	12	81,853	80,179
Do. (Preliminary Editions) ...	Do.	55	.....	27,200	26,200
Do. (Village Boundary Editions)	Do.	. .	62	7,200	14,400
Old Style Sheets	1"-1 mile & 1"-4 miles	.....	47	14,687	21,883
MISCELLANEOUS.					
Atlas of India Series	1"-4 miles	.....	137	16,400	16,566
Provincial Maps	Various	2	1	2,200	3,212
District Maps	1"-4 miles	.....	17	5,157	4,970
Administration Report Maps ...	1"-8 miles to 1"-16 miles	.... .	27	3,437	1,292
Plans of Cities and Cantonments ...	Various	5	271	4,854	11,311
Index Maps	Do.	3	54	36,390	9,099
Miscellaneous Maps	Do.	193	49	291,019	68,184
Totals for 1914-15	.....	**500**	**785**	**615,519**	**3,82,246**
Corresponding totals for 1913-14 ...	.....	728	153	574,101	3,26,077

LETTERPRESS.

1. Catalogue of Maps published by the Survey of India corrected to 1st January 1915. *Price Re. 1.*
2. Circular Orders (Administrative) issued from 1st January 1909 to 31st December 1913.
3. Government of India Orders issued from 1st January 1909 to 31st December 1913.
4. General Report 1913-14. *Price Rs. 2.*

II.—DEHRA DŪN OFFICES.

COMPUTING AND TECHNICAL OFFICES.

80. Computing Office.—A new and much shortened method for the adjustment of triangulation nets has been devised. This has been already applied to the closing of the Baluchistān triangulation and the larger work of the Burma triangulation has been begun. A single triangle of the Manipur Meridional series has to be reobserved and this prevented further progress with the adjustment during the year 1914-15. The necessary observations will shortly be made. The work of adjusting the Burma triangulation was previously regarded as of such magnitude that it could not well be taken up until the triangulation was finally completed, which might mean a delay of ten years. On the other hand the data of the triangulation could not be published until some adjustment had been effected. The new method will give values which may be published without further delay. In this connection values of M, a criterion of the accuracy of the position of triangulated points, have been computed for all geodetic series.

A great effort was begun in March to ensure the publication of the 900 triangulation pamphlets in reasonable time. The past year has been considered a favourable opportunity for this and for the adjustment mentioned above, as a number of computers of the several field parties became available for part of the season owing to the cutting down of field programmes. Data for 45 pamphlets have been compiled and compared during the year; but the rate of progress has now reached 12 per month and it is hoped that this will soon be increased to 20 including the printing and binding.

Some heavy computations in connection with the change from the Everest spheroid of reference to the most recent (or any subsequent) spheroid have been made. The results will appear in Professional Paper No. 16, now in the press.

Computations of dynamic and orthometric heights of nine lines of levelling, *viz*:—Rāwalpindi to Murree, Srīnagar to Islāmābād, Akhaura to Dacca and Farīdpur, Pāchuriā to Porādaha, Comilla to Chittagong, Farīdpur to Barisāl, Meerut to Delhi, Thazi to Prome, and Elephant Point to Pyinmanā and Thazi, have been accomplished.

The transit time observations made in connection with the wireless longitude determinations have all been reduced.

Data from original records were supplied to 29 departmental and non-departmental officers, and a large number of requisitions for Professional forms was attended to.

It has been decided to revise the Auxiliary Tables and to stereotype all the tables. With the old arrangement it has been difficult to keep these tables up to date, as, on account of the labour of composing, a large edition was printed on each occasion; when all the tables are stereotyped a much smaller edition will suffic . and arrangements for adding new tables will accordingly be easier. A start has been made with the map graticule tables which had got into a state of some confusion. Five figure tables of log sines, cosines, tangents and cotangents have been arranged and prepared in a new form.

Additional racks have been, and are still being, provided by the workshop. It is hoped that the records and stock, which are constantly increasing, will soon be adequately stored and indexed. This has been hitherto physically impossible owing to lack of space and rack accommodation.

The binding of Departmental Paper No. 7, of Volume VI of the Records, and of several Levelling and Triangulation pamphlets was completed, and that of Professional Paper 15 and of Volume VIII of the Records, in two parts, is in the hands of the binders.

81. Type Printing Office.—The following publications have been printed during the year :—

(1) Departmental Paper No. 7. The Bar Comparisons of 1907 and 1908, *By Major H. M. Cowie, R.E.*—39 pages.

(2) Addendum to Heights of Bench Marks in sheet 43.—55 pages.

(3) Records of the Survey of India, Volume VIII, in two parts :—
Part I.—Explorations in Tibet and neighbouring regions.—214 pages.
Part II.—Explorations in Tibet and neighbouring regions.—198 pages.

(4) List of Survey of India publications as revised and re-arranged by Major E.A. Tandy, R.E.—9 pages.

(5) Five figure Logarithmic tables of log sines, cosines, tangents and cotangents.—12 pages*.

(6) 20 Triangulation Pamphlets.

Professional Paper 16 "The Earth's Axes and Triangulation" is in press (printed to page 68) and the composing and stereotyping of the graticule tables have been begun.

82. Special Operations.—The trestle alluded to in last year's report has been satisfactorily completed. The largest type of theodolite can now be raised for observation purposes to a height of 65 feet above ground level, and its stability is such that the probable error of observation is not more than 50% greater than if it were placed on a solid masonry foundation. A description is given in Volume VII of the Records.

An instrument for calculating the attractive effect of topography on plumbline deflection has been designed by Mr. deGraaff Hunter and is now under construction. It is only necessary to run the pointer round the contour on a map and the effect in the meridian and the prime vertical can be read off on two drums. This will render possible the analysis of the earth's crustal density in much greater detail than could be attempted previously on account of the enormous labour of calculation involved.

Experiments have been made with an optical arrangement which in some cases may replace the heliotrope and the use of lamps and lampmen for triangulation. The arrangement has also a possible use in connection with secret signalling from aeroplanes and is now being considered by the Aeroplane Committee of the Board of Invention and Research, London.

A simple instrument for plotting points with given coordinates on maps has been designed and made.

83. Workshop.—The facilities of the workshop have been considerably increased by the acquisition of a small electric motor. Lack of space and general poorness of accommodation still cramp the work very much, and it is urgently necessary that new buildings for workshops should be erected.

84. Observatories.—Meteorological observations have been continued as in last year.

The Omori Seismograph has been in regular use and a list of the earthquakes recorded will appear in the Records, Volume IX. It has been noticed that about 50% of the earthquakes recorded in three years occur in, or very close to, March or April.

Photographs of the sun have been taken on 333 days, the sun being obscured by clouds on the remaining days.

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* Stereotyped.

The services of Lieutenant K. Mason, R.E. were lent for about one month, during which time he did most of the erecting of the new base line apparatus. The actual completion of the work has since been effected.

85. Preservation of Trigonometrical Stations.—1,079 stations were repaired by district officers at a cost of Rs. 5,475-3-11.

Out of 351 districts from which reports are annually due 24 failed to make returns.

86. No. 2 (Dehra) Drawing Office.—During the year the office was organised in sections to deal with :—

(*a*)—Cantonment maps ;

(*b*)—Triangulation charts ;

(*c*)—Geographical maps on the one-millionth, two-millionth and four-millionth scales ;

(*d*)—Topographical maps on the half-inch scale ;

(*e*)—Miscellaneous subjects.

The Map Record Section was also re-organised ; the maps and originals are being re-arranged and catalogues prepared.

The following is a summary of the work of the office during the year 1914-15 :—

Class of map.	Sheets sent for publication.	Remaining in hand.
Map of Tibet, with altitude layers and with snowy areas in white, $\frac{1}{2{\cdot}5\ \text{Million}}$ scale	4	
Geographical maps, $\frac{1}{M}$ scale	1	9 *(a)*
Miscellaneous Geographical maps on various scales ...	2	
Index chart to the Great Trigonometrical Survey of India, $\frac{1}{3\ \text{Million}}$ scale, in 4 sections		4
Miscellaneous Extra Departmental maps and plans	5	12
Miscellaneous Scientific diagrams and charts ...	14	4
Preliminary degree triangulation charts ...	10	44
Final do. do.	11	
Miscellaneous Triangulation charts	34 *(b)*	
4-inch Standard sheets	2	12
Cantonment maps	52 Cantonments *(c)* 198 Sheets.	15 Cantonments 76 Sheets.
Explorers' maps	10	10
Miscellaneous Departmental publications ...	7	

(a) Includes 2 for the $\frac{1}{2\ \text{Million}}$ series by reduction, *(b)* includes 32 skeleton degree triangulation charts, *(c)* completed and stored.

(*a*) The systematic correction of the *Cantonment maps* from material supplied by the Military Works Services, which was begun in August 1914, has been continued. The work has proved heavier than had been expected but will probably be considerably less in subsequent years than it has been during the first year. If this does not prove to be the case the present strength of the section will have to be increased, and—a more difficult matter—more accommodation will have to be found for it.

(*b*) The section which deals with the *Triangulation charts* has been strengthened and is now probably able to keep pace with the compiling and the printing of the pamphlets. When the men became thoroughly accustomed to the work it is hoped that an outturn of 20 charts per mensem will be attained. A large scale chart, on the scale of 1:3,000,000 showing all the Geodetic work that has been done, is in preparation and it is hoped that it will be ready before the end of 1915.

(*d*) *Half-inch sheets compiled from one-inch maps.* During this year 2 sheets have been fair-drawn and submitted for publication and 12 are in hand. Proofs of 1 sheet have been received for colouring and examination but have not yet been completed.

(*e*) *Map of Tibet on the scale of* $\frac{1}{2,500,000}$:—The preliminary edition of this, in four sheets, has been published; this is the most important piece of layer printing that this office has undertaken. The layer system is severely tested in this map as it includes not only the highest mountains in the world but also an area to the south of Turfan which is 330 feet below the mean level of the sea. Areas which are generally snow-clad are shown in white with green-blue form-lines to indicate their configuration. An improved edition is in contemplation and will be taken up as soon as time can be found.

87. Photozinco. Office.—During the year the work undertaken comprised:—Forest maps; Cantonment maps; Triangulation charts; Levelling Charts; The Tibet map in four sections, with layers; Two layered maps illustrating the Pendulum operations; Degree Sheets drawn in No. 6 Drawing Office; Provisional Degree Sheets; Plan of the site of the new Capital at Delhi. A good deal of extra work was thrown on the office owing to the heavy demands made by the Chief of the General Staff for maps for war purposes.

It has been found necessary to indent for a second machine press as the work of the office is steadily increasing, the table below shows the increase during the last three years:—

Year.	No. of Subjects.	No. of Negatives.	No. of Pulls.	Chocolate and Cyanotype prints.
1912-13 ...	1,973	1,909	236,766	1,039
1913-14 ...	2,046	2,376	244,140	1,695
1914-15 ..	**1,898**	**2,267**	**345,520**	**663**

It is to be remarked that up to 1912 the work consisted almost entirely of printing in black; this can be done more rapidly than colour work which demands accurate registration, work prior to 1912 has therefore not been shewn here for purposes of comparison.

88. Forest Map Office.—The total number of maps issued, both to officials and the public, during the year, amounted to 17,955, which is an increase of 11,514 over last year's total. The gross face value of these maps was Rs. 34,116, and the net amount realised from sales was Rs. 6,864. Of this amount, Rs. 6,524 was recovered by book-debit and Rs. 340 by cash from sales to private individuals and trading companies. The total sum realised from sales in the previous year was Rs. 2,348, so that in actual sales, there has been an increase of Rs. 4,516, during the year under review. The number of maps and field sections received for storage during the year was 16,408, besides 210 computation volumes, angle books and traverse field-books, and 95 traverse charts and plot sheets.

The following table shows, in abstract form, the work dealt with by the office :—

Class of map.	Number of sheets.		
	In hand.	Drawn and sent for publication.	Published.
1-inch, 2-inch and 4-inch maps of Forest Surveys	321	52	42
Special maps of India ...		10	8
Provincial, Divisional and District Forest maps ...	40	5	10
Working Plans and Miscellaneous maps ...	24	20	13
Totals ...	385	87	73

III.—CIRCLE AND LOCAL DRAWING OFFICES.

89. No. 3 Drawing Office (Northern Circle).—During the year 120 one-inch sheets previously surveyed and drawn by parties were dealt with and submitted for publication; 12 other fair sheets, not included in the above number, were also sent to press, *i.e.*, 3 on the half-inch scale, drawn in No. 2 Party's office and 9 prepared in the Drawing Office comprising 2 sheets on the quarter-inch scale fair drawn, 3 sheets on the one-inch scale fair drawing completed to margin, and 4 sheets on the one-inch scale received from the Superintendent, Map Publication and brought up to date.

The proofs and colour patterns of 142 sheets including 34 arrears from last season, and 108 out of the 116 received from the Superintendent, Map Publication of this season's return, were examined and sent to press.

Half-inch sheets compiled from one-inch maps.—During the year 3 sheets have been fair drawn and submitted for publication leaving the fair drawing of 28 in hand and that of 19 sheets of which the component one-inch sheets had been published, not yet commenced.

Quarter-inch sheets compiled from one-inch or half-inch maps.—Press order has been given for sheet 34 N and the colour guides of sheet 43 D have been asked for; the fair drawing of 6 sheets is in hand and that of 3 sheets of which the component one-inch or half-inch sheets had been published, is not yet commenced.

12 sheets (hill and outline) of the Turco-Persian Frontier were also fair drawn this year in this Drawing Office.

90. No. 4 Drawing Office (Southern Circle).—During the year 53 one-inch and 3 half-inch sheets, which had been previously surveyed and drawn by parties, were finally examined and submitted for publication. At the end of the year every sheet, the survey of which was completed during previous years, had been submitted.

Half-inch sheets compiled from one-inch maps.—11 sheets were drawn and submitted for publication. At the end of the year 7 sheets were in hand and 46 sheets, of which the component one-inch sheets had been published, had not been commenced.

Quarter-inch sheets compiled from one-inch or half-inch maps.—One sheet was drawn and submitted for publication. At the end of the year 3 sheets were in hand and 3 sheets, of which the component one-inch or half-inch sheets had been published, had not been commenced.

Six preliminary one-inch sheets were redrawn and submitted for publication.

The colouring, examination, &c. of 78 proofs and the hill shading of 51 sheets were undertaken.

A number of pupils were instructed in drawing. Considerable assistance was given to parties to enable them to complete their drawing during the recess season.

The Photo.-Zinco. Section undertook the photographic and zincographic work required in the circle. 10 soldier surveyors, &c. were put through a course of training.

91. No. 5 Drawing Office (Eastern Circle).—During the year 43 one-inch sheets and 6 half-inch sheets previously surveyed and drawn by parties were dealt with; all of the one-inch sheets and one of the half-inch sheets were examined and submitted for publication. In addition to the above 1 one-inch sheet No. 79 $\frac{J}{12}$ was compiled from settlement surveys and submitted for publication together with 1 one-inch sheet which was in arrears from last year.

Proofs of 42 sheets were received and 39 were examined and sent to press.

At the end of the year every sheet, the survey of which was completed during previous years, had been submitted.

Half-inch sheets compiled from one-inch maps.—During the year 6 sheets have been fair drawn and 1 sheet submitted for publication leaving 29 sheets in hand of which 20 are nearing completion.

Quarter-inch sheets compiled from one-inch or half-inch maps.—During the year the drawing of 6 sheets has been completed while 2 sheets have been submitted for publication, 5 sheets are under examination and will be submitted shortly and the drawing of 17 sheets is nearing completion. Two proofs have been received for colouration, &c., of which one has been sent to press together with two proofs of previous years.

One degree sheet (94 G), a large portion of which was surveyed on the quarter-inch scale, has been fair mapped, is now under examination and will be submitted for publication shortly.

Three degree triangulation charts have been examined and submitted to the Superintendent of the Trigonometrical Survey.

92. No. 6 (Simla) Drawing Office.—As during the previous year this office was organized in 2 sections.

The *Army Section* has dealt with the preparation and reproduction of maps and plans for the use of the Army in India while the *Survey Section* has been employed on the preparation of trans-frontier maps on the one-millionth, quarter-inch and half-inch scales.

Most of the work of the *Survey Section* has consisted in redrawing in modern style, and sometimes to a reduced scale, the maps already existing, with the incorporation of such additional information of recent date as may have been available.

93. Bihār and Orissa Drawing Office.—(*Imperial Standard Mapping Section*). Owing to the removal of the Bihār and Orissa Drawing Office to Patna the Imperial Mapping Section was placed under the direction of the Director of Surveys, Bengal and Assam, from 1st October 1914. The office submitted the fair mapping for publication of 48 preliminary one-inch sheets of Bihār and Orissa covering an area of 11,277 square miles appertaining to the following districts:—

Monghyr, Shāhābād, Patna, Gayā, Palāmau, Hazāribāgh, Rānchī, Mānbhūm and Singhbhūm.

Four other sheets have also been completed and will shortly be sent for publication; 39 sheets are in hand and 12 sheets of the Province remain to be compiled.

For Bengal 3 sheets are nearly ready and 36 sheets are in hand.

An experiment was made to compile a sheet from cadastral detail as mapped on the four-inch Thana maps; it is hoped that the experiment will be successful and that it will lead to the reduction of arrears.

PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS.

94. Northern Circle.—*The Punjab Riverain Detachment* of the Northern Circle was exclusively employed as in previous years on local surveys in the Punjab. The detail of the work is shown on page 16.

No. 20 Party (Cantonment).—This Party continued the detail survey of the Cantonments shown on page 15.

Simla Survey Detachment continued its survey work in the Simla Municipality, for details see pages 16 and 17.

The Khetran-Lehari boundary between the Punjab and Baluchistān was demarcated by Captain R. Foster, I.A., of No. 4 Party at a cost of Rs. 1,316-11-3 which was paid for in equal shares by the two Governments concerned.

95. Eastern Circle.—Lieut.-Colonel Crichton, C.I.E., wrote a comprehensive note on the subject of Revenue Surveys for the information of the Chinese Government who are contemplating the introduction of Land Settlement and Surveys on a modern basis in their country.

96. General.—Two Provincial officers have been lent to the Bombay Government for the *Bombay City Survey*.

Various *Forest Surveys* and forest maps were carried out as usual for the Forest Department: for details see pages 13, 14 and 37.

A portion of the *Nepāl-Pilibhīt boundary* has been re-aligned and surveyed by a detachment, the details of the work are at pages 23 and 24.

97. Map Publication Offices.—During the year numerous maps, plans, and illustrations were reproduced for many Government departments and offices, less than half of the work of the Photo.-Litho. Office being of a purely departmental nature. The reproduction of such work can be undertaken without interfering with the normal work of the department so long as the maps, &c. are submitted in a state suitable for reproduction and do not require to be redrawn.

No. 1 (Head Quarter) Drawing Office prepared amongst others the Bassein and Henzada maps for District Gazetteers, Postal maps of Bengal, Assam, and Bihār and Orissa, Telegraph and Railway maps for India, as well as several manœuvre maps: a considerable number of Commission forms and Certificates were also engraved.

98. Mathematical Instrument Office.—Since the outbreak of war this office has undertaken the manufacture of many 9-inch and 3-inch heliographs (444). It has also issued and repaired many other military instruments such as telescopes, binoculars, rangefinders, &c. Overtime has been worked to the extreme limit that the workmen could stand, and a certain amount of civil work has been set aside in order to meet the demands made by Military Departments.

The office as usual supplied and repaired instruments for every Government department in India.

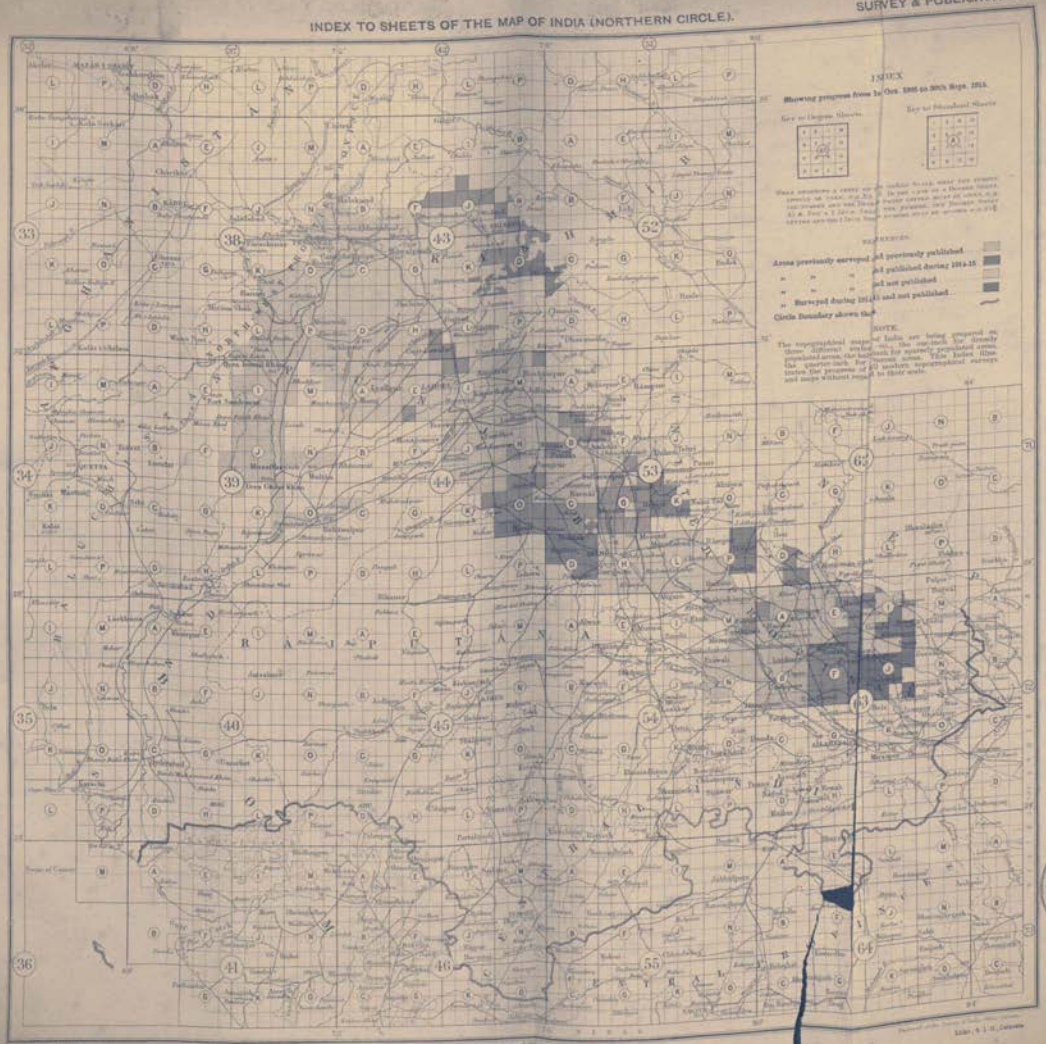
99. Dehra Dun Offices.—During the year a large number of maps, &c., were reproduced for other Government departments and offices while the Computing Office also complied with requisitions for data.

LIST OF INDEX MAPS.

1. Modern surveys and publication, Northern Circle.
2. ,, ,, ,, ,, Southern ,,
3. ,, ,, ,, ,, Eastern ,,
4. Publication of modern one-inch series, Northern Circle.
5. ,, ,, ,, ,, ,, Southern Circle.
6. ,, ,, ,, ,, ,, Eastern ,,
7. ,, provisional editions of one-inch series, Northern Circle.
8. ,, ,, ,, ,, Eastern ,,
9. ,, modern half-inch series for India.
10. ,, ,, quarter-inch ,, ,,
11. ,, 'India and Adjacent Countries' series, scale $\frac{1}{1,000,000}$.
12. ,, Indian sheets of "La Carte Internationale du monde," scale $\frac{1}{1,000,000}$.
13. ,, 'Southern Asia' series, scale $\frac{1}{2,000,000}$.
14. Progress of the Great Trigonometrical Survey.

INDEX TO SHEETS OF THE MAP OF INDIA (NORTHERN CIRCLE).

SURVEY & PUBLICATION.



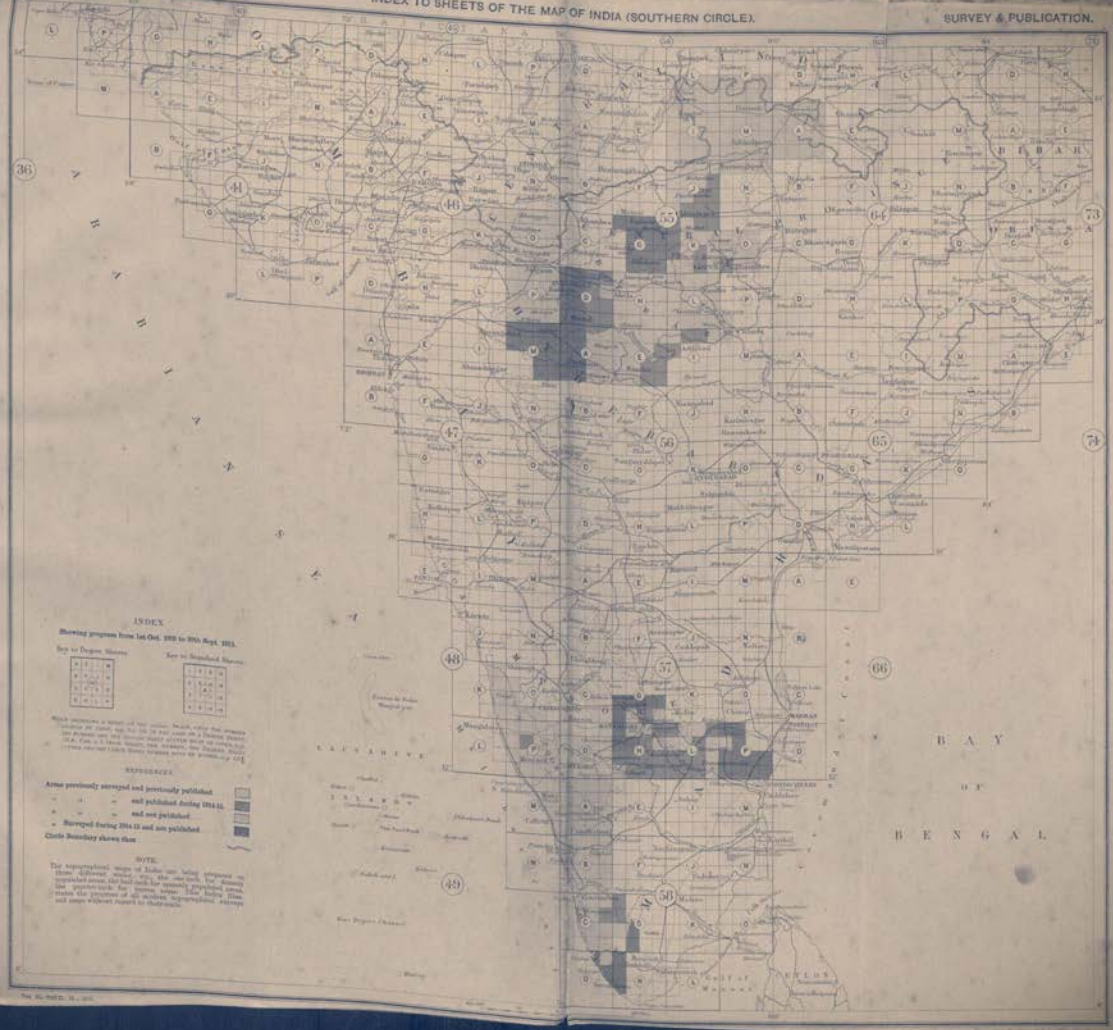
LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

MODERN SURVEY & PUBLICATION

Northern Circle).

INDEX TO SHEETS OF THE MAP OF INDIA (SOUTHERN CIRCLE).

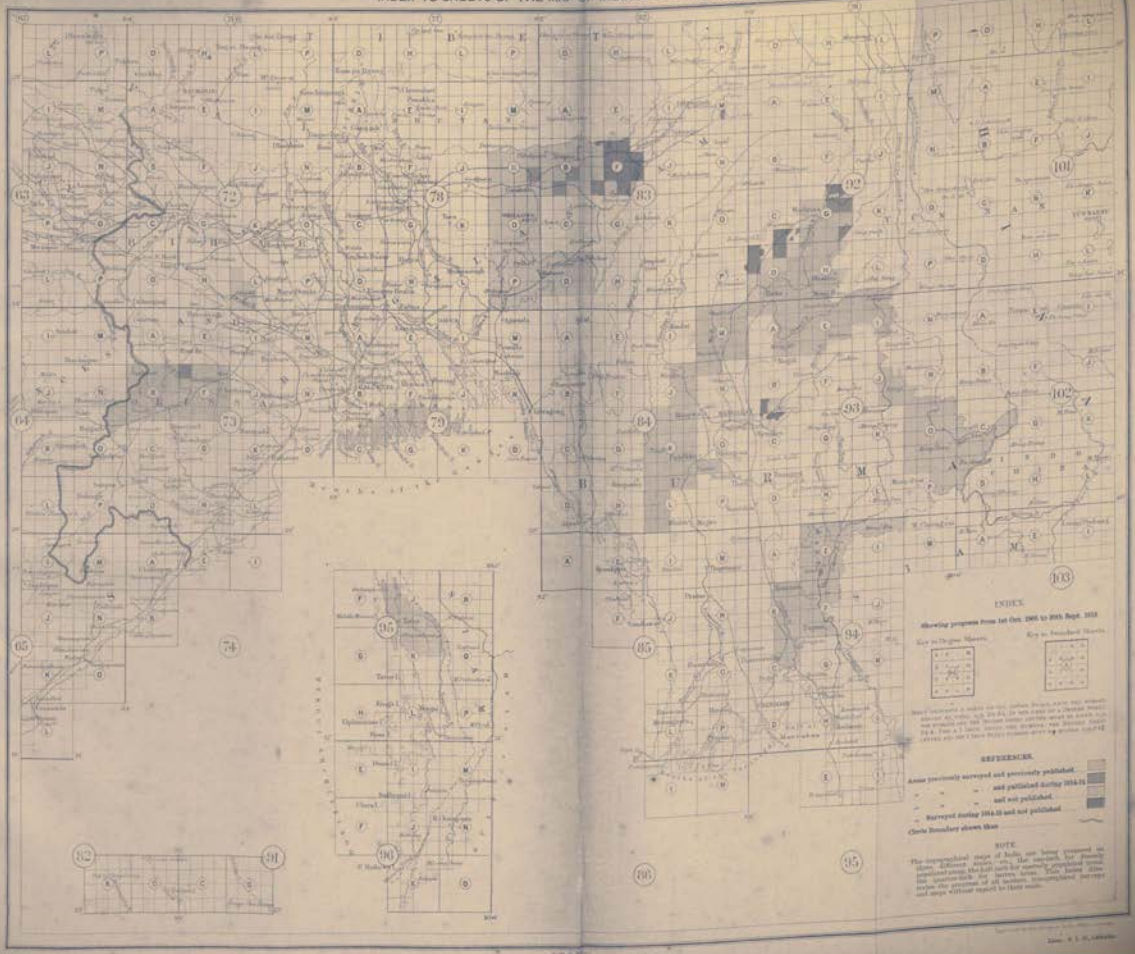
SURVEY & PUBLICATION.



SURVEY & PUBLICATION

(Southern Circle).

INDEX TO SHEETS OF THE MAP OF INDIA (EASTERN CIRCLE).


INDEX.
Showing progress from 1st Oct. 1905 to 30th Sept. 1910
Key to Degree Sheets.
Key to Standard Sheets.
REFERENCES.
Areas previously surveyed and previously published.
" " " and published during 1904-10.
" " " and not published.
" Surveyed during 1904-10 and not published
Circle Boundary shown thus
NOTE.

MODERN SURVEY & PUBLICATION

(Eastern Circle).

INDEX TO SHEETS OF THE MAP OF INDIA (NORTHERN CIRCLE). PUBLICATION OF MODERN ONE-INCH SERIES.

INDEX TO SHEETS OF THE MAP OF INDIA (SOUTHERN CIRCLE).

PUBLICATION OF MODERN ONE-INCH SERIES.

INDEX

Showing progress from 1st Oct. 1905 to 30th Sept. 1912.

Key to Degree Sheets.

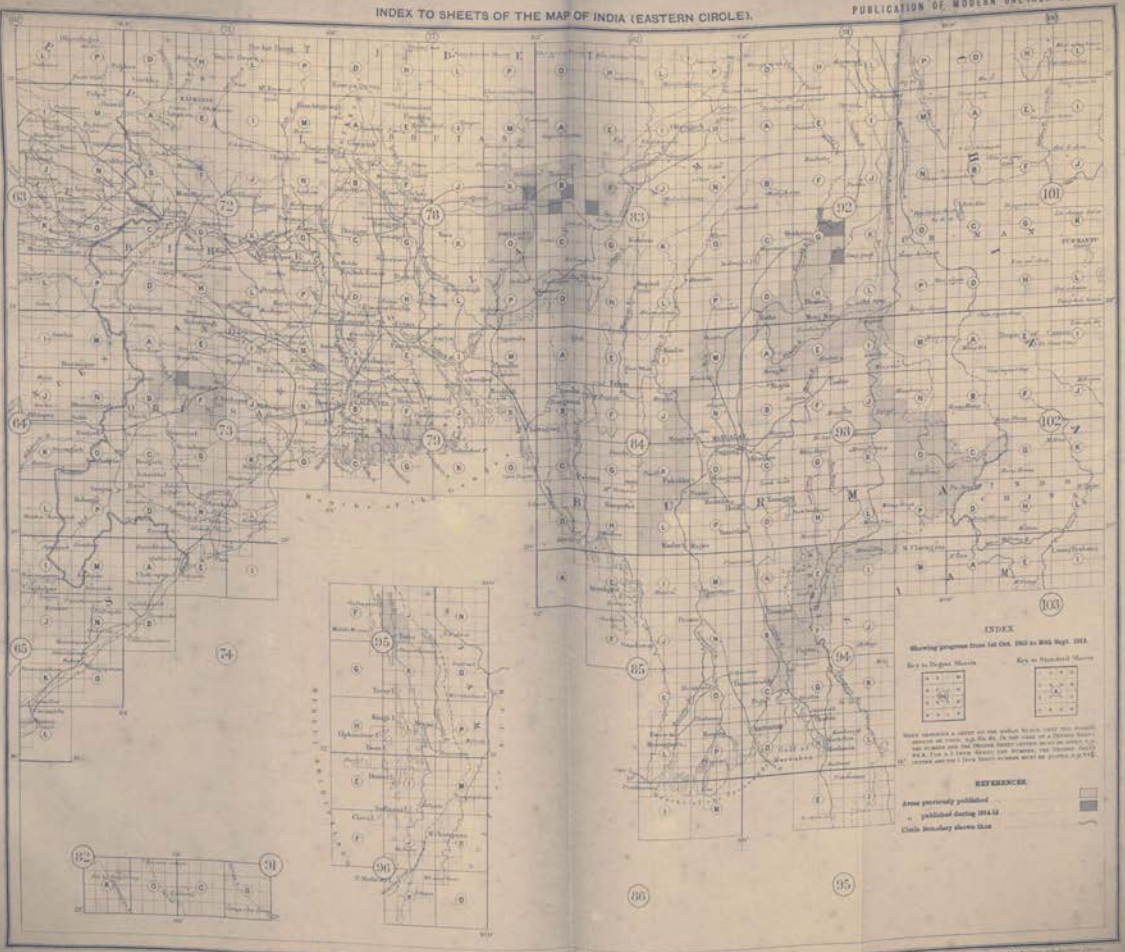
Key to Quarter-Inch Sheets.

REFERENCES

Areas previously published.

" published during 1911-12.

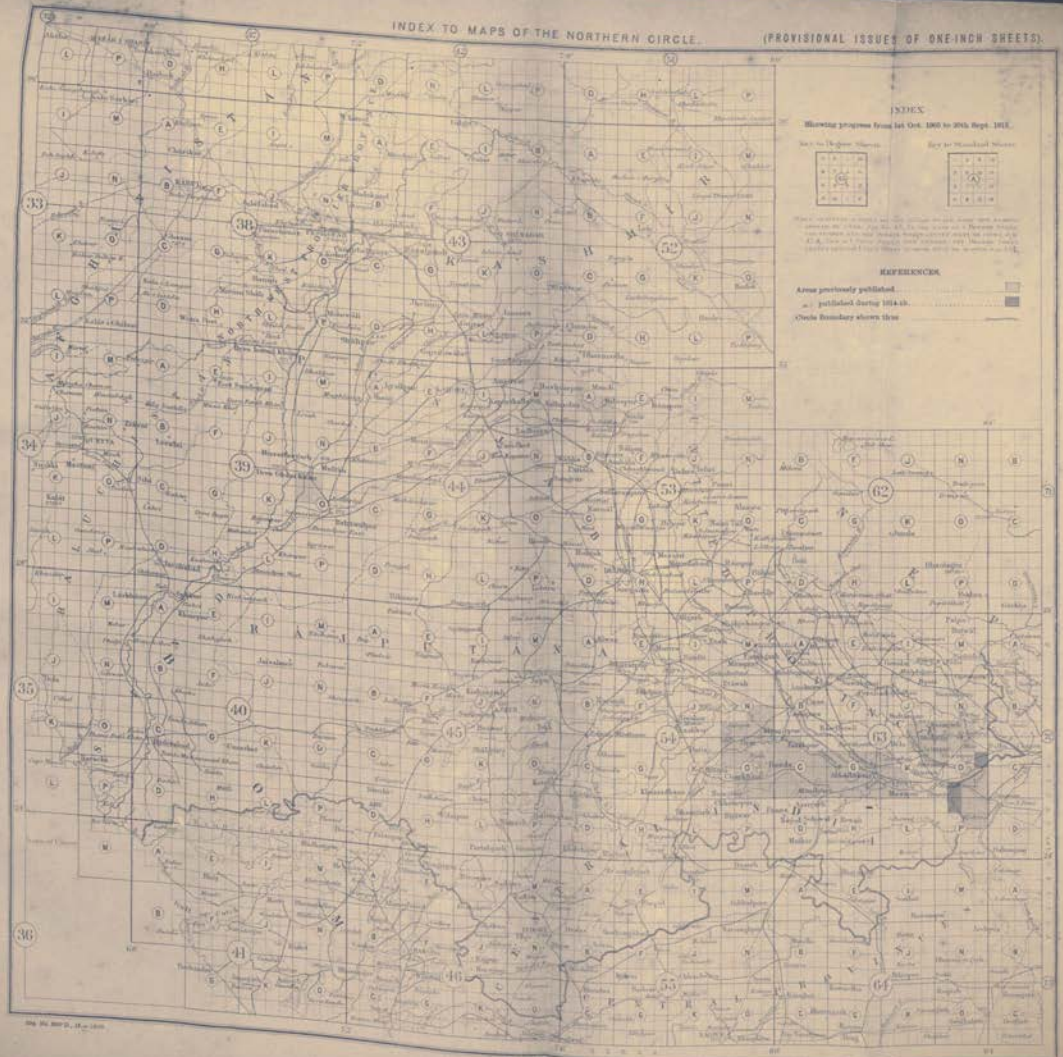
Circle Boundary shown thus


INDEX
Showing progress from 1st Oct. 1913 to 30th Sept. 1914.
Key to Degree Sheets
Key to Standard Sheets
REFERENCES
Areas previously published
" published during 1914-15
Circle Boundary shown thus

MODERN ONE-INCH PUBLICATION

(Eastern Circle).

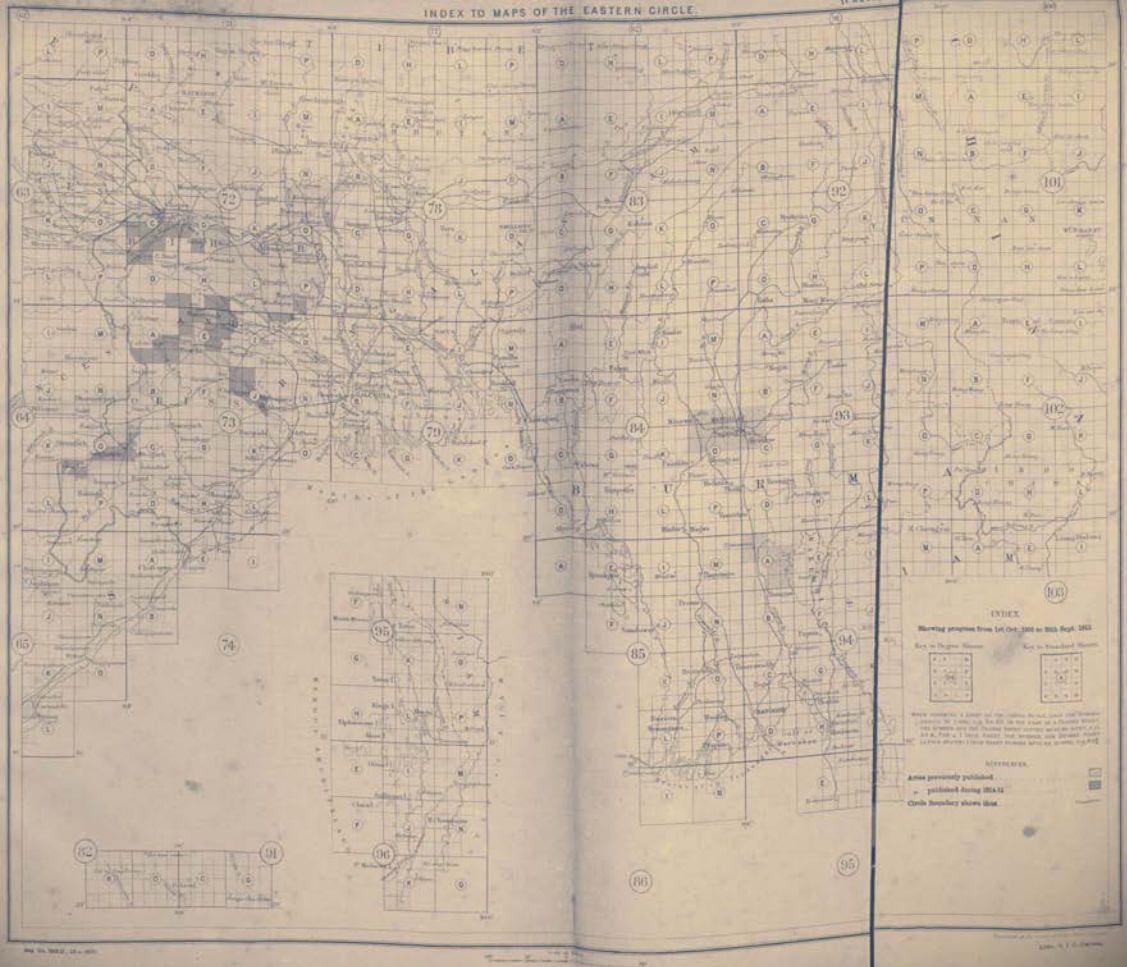
INDEX TO MAPS OF THE NORTHERN CIRCLE. (PROVISIONAL ISSUES OF ONE-INCH SHEETS).



PROVISIONAL ONE-INCH PUBLICATION

(Northern Circle).

INDEX TO MAPS OF THE EASTERN CIRCLE.



PROVISIONAL ONE-INCH PUBLICATION

(Eastern Circle).

PROVISIONAL ONE-INCH PUBLICATION

(Eastern Circle).

INDEX TO THE HALF INCH SHEETS OF INDIA.

The numbers of the sheets of the 1-1,000,000 series are shown thus 55
The letter of the Degree Sheet series thus M
The half-inch sheets are designated by the number of the sheet on the 1/1,000,000, scale and the letter of the degree sheet in which they fall with the letters N.W., S.E., S.W., or S.E., according to their position as quarters of the degree sheets, entered below the degree sheet letter. Thus the number of half-inch sheet containing Jubbulpore is 55 S.E.

REFERENCE.

Areas previously published.

Areas published during 1914-15

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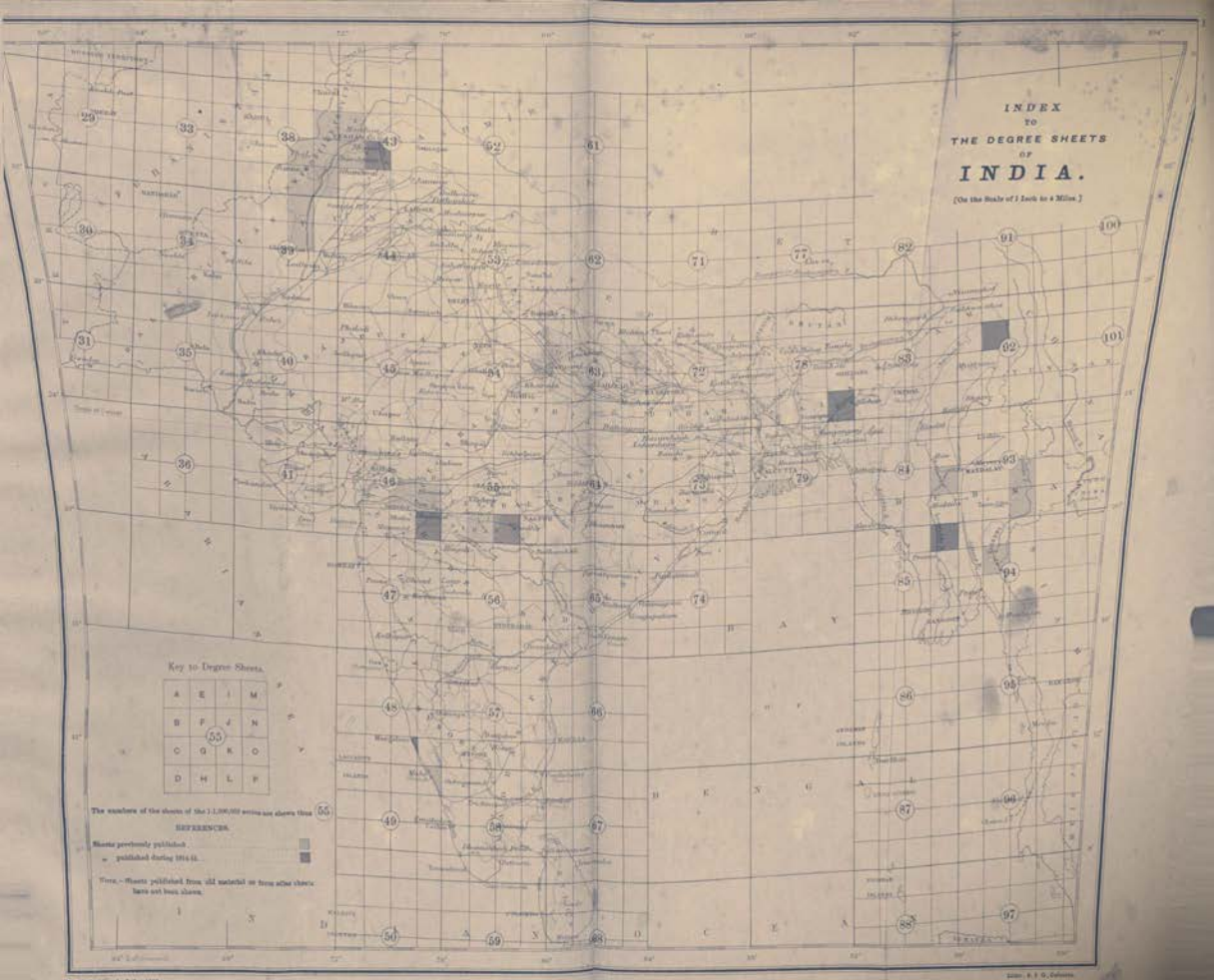

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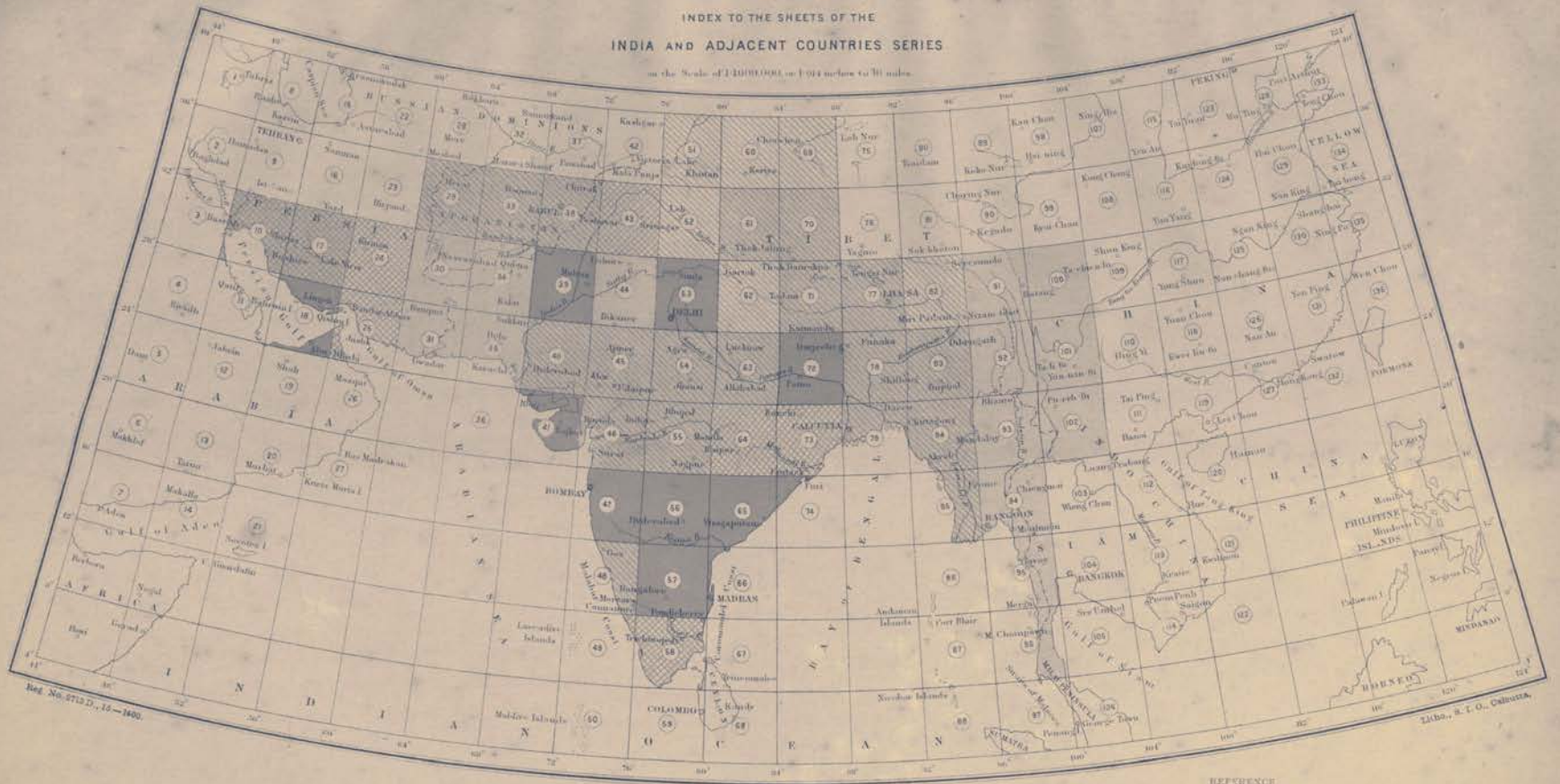

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1915

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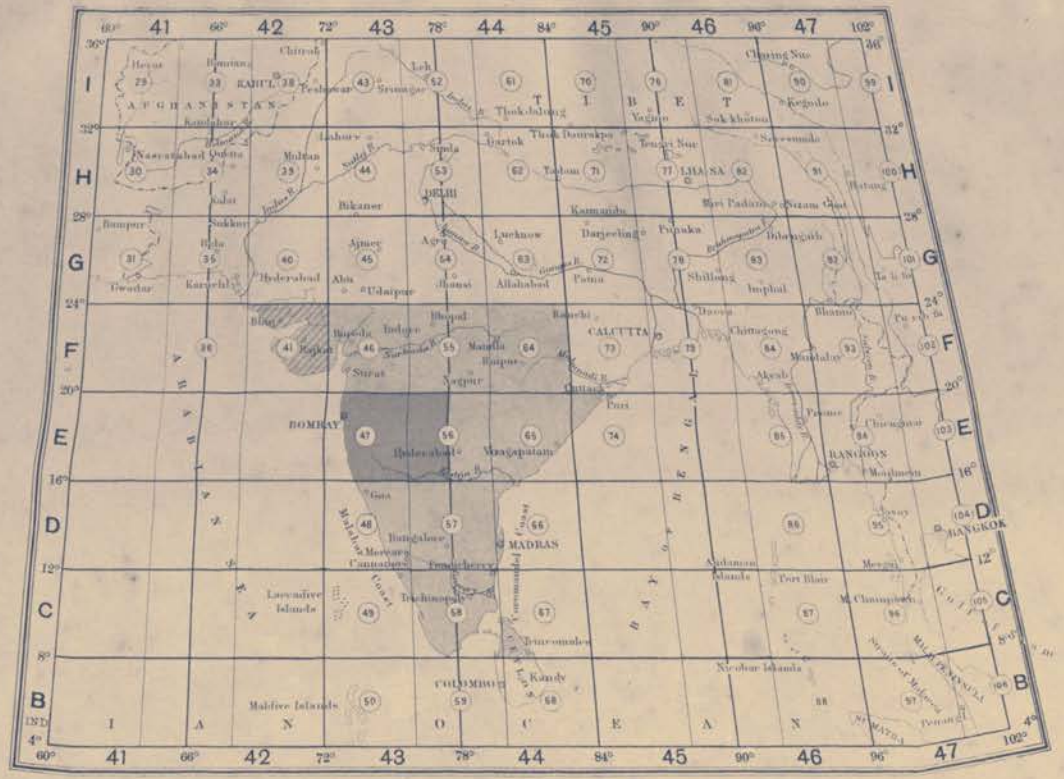

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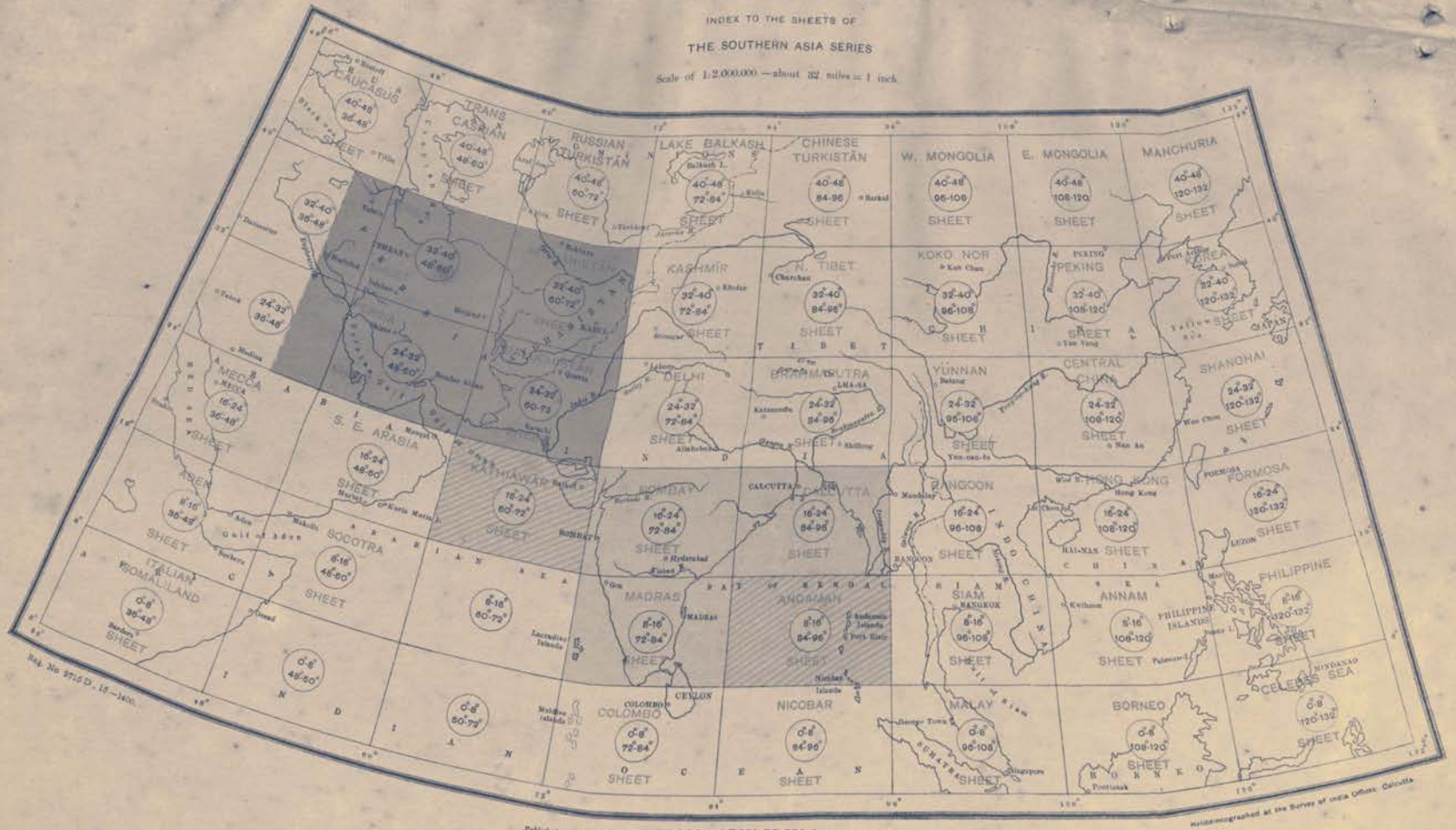

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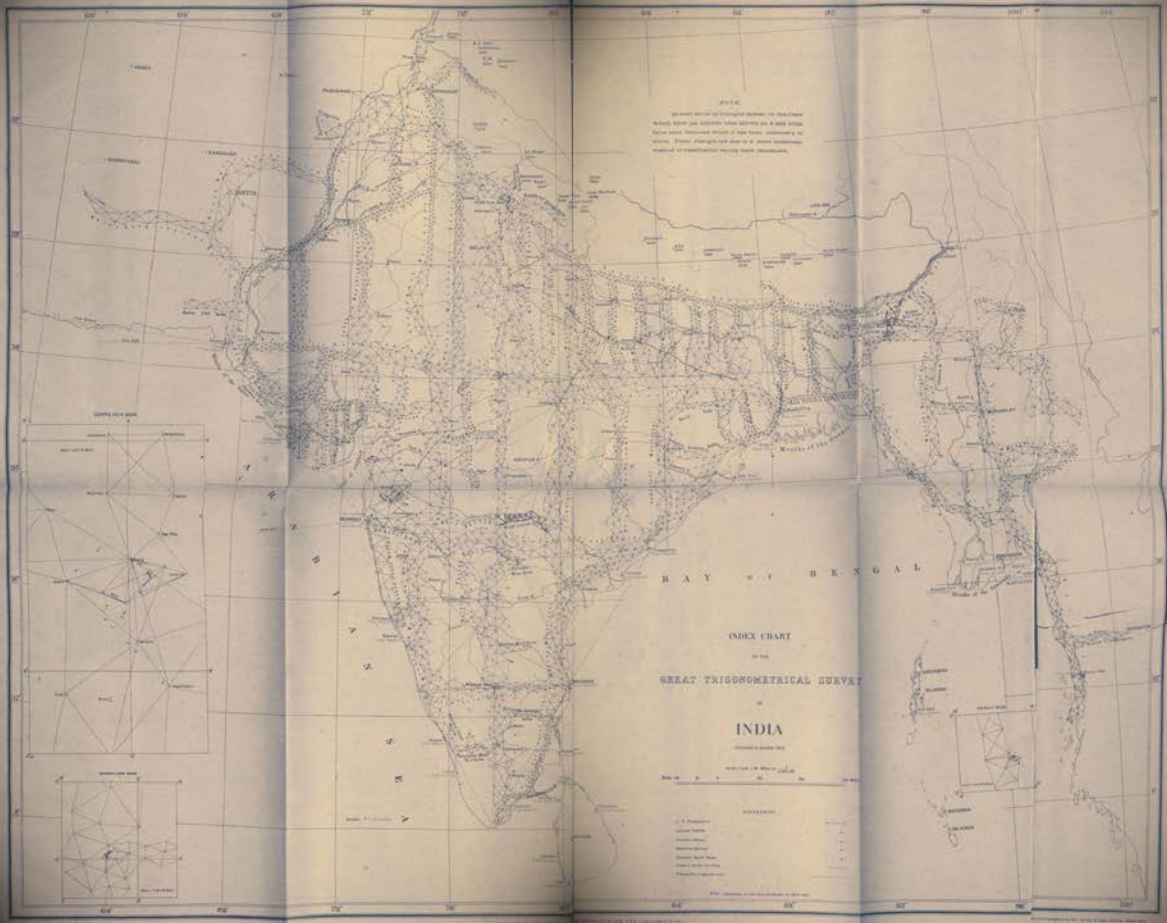
BAY OF BENGAL
INDEX CHART
TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA

Survey of India.

GENERAL REPORT,

1915–16.

From 1st October 1915
To 30th September 1916.

PREPARED UNDER THE DIRECTION OF

COLONEL SIR S. G. BURRARD, K.C.S.I., R.E., F.R.S.,

SURVEYOR GENERAL OF INDIA.

PRINTED AT THE PHOTO.-LITHO. OFFICE, SURVEY OF INDIA,
CALCUTTA,
1917.

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5. ,, ,, ,, ,, ,, Southern ,,
6. ,, ,, ,, ,, ,, Eastern ,,
7. ,, provisional editions of one-inch series, Northern Circle.
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12. ,, Indian sheets of "La Carte Internationale du Monde," scale $\frac{1}{1,000,000}$.
13. ,, 'Southern Asia' series, scale $\frac{1}{2,000,000}$.
14. Progress of the Great Trigonometrical Survey.

Survey of India.

GENERAL REPORT,

1915—16.

From 1st October 1915
To 30th September 1916.

PART 1.—GENERAL REMARKS.

I.—INTRODUCTION.

1. The main parts of this report, as shewn in the "Contents" on the opposite page, are *Part 2—Work of Field Parties, &c.*, summarising the operations of the field parties, grouped under appropriate headings; and *Part 3—Office Work*, which gives a brief account of the year's progress in the head-quarters and other offices. Fuller details of these operations are being published in Volume X of the "Records of the Survey of India."

2. An abstract showing the progress of the topographical programme assigned to the department in 1905, may be found in Table II on page 9. From this it will be seen that the out-turn of topographical survey during the current year was 32,342 square miles; and that this brings the total progress since 1905 to 438,833 square miles, leaving 1,382,767 square miles still to be done.

3. The first three Index maps, at the end of the report, show the progress of this topographical programme both in survey and in publication in the three circles, while the remaining eleven indexes show the progress in publication of the various series of maps appertaining to the scheme, and also the main framework of triangulation on which the Survey of India is based.

4. Table IV on page 32 gives a list of the new publications of the Calcutta Offices during the year. A complete list of departmental publications apart from maps, may be found in the annual "Records of the Survey of India"; and lists of new maps are published quarterly by the department, as well as in the monthly "Notes of the Survey of India."

5. Progress in the Trigonometrical Survey can only be assessed by a study of the "Records of the Survey of India" and the special publications issued at Dehra Dūn. The General Report can attempt little more than a brief abstract of the *locale* and nature of the different operations.

6. The following events are notified:—

(*a*) Two more Imperial Officers have been reverted temporarily to military duty and the services of 2 more officers of the Provincial Service have been accepted by the Army Department during the year.

(*b*) Owing to the shortage of officers the field work of the whole department was again considerably curtailed.

(*c*) The Survey party under an Imperial Officer which accompanied the field-force in Mesopotamia continued survey operations there.

(*d*) The superintendence of the Assam Provincial Surveys on its separation from the Bengal Surveys was taken over by the Survey of India as an experimental measure.

(*e*) The control of the Magnetic Observatory at Kodaikānal was transferred from the Survey of India to the Meteorological Department.

(*f*) The following instruments which are of historical interest but are no longer made use of in the Survey of India were presented to the Trustees of the Victoria Memorial, Calcutta, for exhibition in their Museum:—

(*i*) Troughton and Simms' Grand or 36-inch Theodolite. 1830-1873.

(*ii*) Waugh's 24-inch Theodolite No. 1. 1846.

(*iii*) Ramsden's Zenith Sector. 1802—1825.

(*g*) Four plates and nine lithographic stones used in the production of the first stamps of India in 1854 were presented to the Royal Philatelic Society, London.

(*h*) A new Population Map of India shewing the varying densities of the population by rectangular compartments was designed by Major E. A. Tandy, R.E.

(*i*) A survey was made of the boundary of the Imperial area at Delhi.

(*j*) The Hon'ble Sir James Meston, K.C.S.I., LL.D., V.D., Lieutenant-Governor of the United Provinces visited the Survey of India Offices, Dehra Dūn on 14th July.

The Hon'ble Mr. Claude Hill, C.S.I., C.I.E., Member in charge Department of Revenue and Agriculture visited the Survey of India Offices, Dehra Dūn on 31st July.

The Hon'ble Mr. Mant, Secretary to the Government of India, Department of Revenue and Agriculture, visited the Survey of India Offices, Calcutta on 28th and 29th of January. He also visited the Survey of India Offices, Dehra Dūn on 27th and 28th March and on 31st July.

II.—ADMINISTRATION AND PERSONNEL.

7. The actual cost of the department for the financial year ending 31st March 1916 and of the 2 previous years is shown below:—

	1913-14.	1914-15.	1915-16.	REMARKS.
	Rs.	*Rs.*	*Rs.*	
Gross actual cost ...	35,30,068	33,32,541	**30,17,349***	
Deduct receipts and credits	9,35,982	9,48,397	**8,47,459***	*These figures are not final.
Net actual cost ...	25,94,086	23,84,144	**21,69,890***	

8. Colonel Sir S. G. Burrard, K.C.S.I., R.E., F.R.S., administered the department throughout the year.

9. In the Imperial Service the following losses occurred:—Captains P. G. Huddleston, R.E., and J. A. Field, R.E., were killed in action on 25th March and 13th July respectively. Captains G. F. T. Oakes, R.E., and E. C. Baker, R.E., died on 15th July and 19th September respectively, from wounds received in action. Captain R. L. Almond, R.E., who had been reported as wounded and missing on or about 28th October 1914 was reported as having been killed on or about that date. Captain E. B. Cardew, R.E., was reported as wounded and missing on 26th September 1915. The total number of Imperial Officers temporarily reverted to military duty on account of the war is now 36 and the total casualties to date in killed, died of wounds or missing are now 7. Colonel W. J. Bythell, R.E., retired from the service on 23rd May 1916.

In the Provincial Service Mr. W. Skilling died on 9th October 1915, and Mr. T. Shaw, a retired officer who was re-employed on special duty in Assam, also died on 24th March 1916. Messrs. P. J. Barrington, and Kanak Singh retired; Mr. W. E. Johnson, who was employed under the Government of Burma and Mr. C. G. Lee, who was employed under the Government of Bengal also retired. Messrs. W. Newland and B. M. Berrill who are employed under the Government of Bombay are seconded in the Survey of India. Mr. O. J. H. Hart who was employed under the Government of Bengal has reverted to the Survey of India. The total number of officers of the Provincial Service whose services have been accepted by the Army Department is now 21. Out of these one has been killed in action and one has since reverted to the Survey of India.

In the Upper Subordinate Service 1 officer was discharged, 3 probationers were confirmed and 2 probationers were appointed, also 3 surveyors were promoted into this service from the Lower Subordinate Service.

Mr. R. Taylor, Manager, Photo. Section, Photo.-Litho. Office died on 11th October 1915. Senior Sub-Assistant Surgeon Thakur Singh, attached to the Trigonometrical Survey Office died on 14th May 1916. Mr. Hira Singh, Rai Sahib, Head Assistant, Trigonometrical Survey Office retired.

The total strength of the department at the close of the Survey year was 45 Imperial Officers, 120 Provincial Officers and 46 Upper Subordinates besides specialists, clerks, lower subordinates and menials; but the number of officers of the first two services actually employed in the department were 16 Imperial Officers and 101 Provincial Officers, the remainder being on military duty.

10. The following Honours were conferred on members of the department during the year:—

To be Brevet Lieutenant-Colonel.—	Major C. M. Browne, D.S.O., R.E.
To be Companions of the Distinguished Service Order.—	Captains S. W. S. Hamilton, R.E. and A. A. Chase, R.E.
Military Cross.—	Captain H. J. Couchman, R.E.
Cross of "Chevalier de la legion d'honneur."—	Brevet Lieut.-Colonel C. M. Browne, D.S.O., R.E.
Mentioned in despatches.—	Lieut.-Colonel F. W. Pirrie, I.A. (thrice mentioned).
	Major H. H. Turner, R.E.
	Brevet Lieut.-Colonel C. M. Browne, D.S.O., R.E. (twice mentioned).
	Captain E. B. Cardew, R.E.
	,, A. A. Chase, D.S.O., R.E.
	,, K. Mason, R.E.
	,, H. E. Roome, R.E.
	Surveyor Laltan Khan.
	,, Muhammad Khan.
Insignia of "Officer of the Order of the Crown of Italy."—	Major H. Wood, R.E.
Kaisar-i-Hind Medal of the First Class.—	Mr. F. R. Vandyke, Manager, Litho. Section, Photo.-Litho. Office, Calcutta,
Kaisar-i-Hind Medal of the Second Class.—	Mr. Sher Jang, Khan Bahadur, Sub-Assistant Superintendent, Upper Subordinate Service.
Title of Rai Sahib.—	Mr. Jamna Prasad, Sub-Assistant Superintendent, Upper Subordinate Service.
,, ,,	,, Ram Prasad, Sub-Assistant Superintendent, Upper Subordinate Service.
,, ,,	,, Ishan Chandra Deb, B.A., Head Computer, Trigonometrical Survey Office.

Mr. A. J. A. Drake, who is a member of the Mussoorie Volunteer Rifles and is employed on military duty, has been promoted to 2nd-Lieutenant in that corps and appointed a temporary Lieutenant in the Army.

Mr. J. C. St. C. Pollett, who is a member of the Bangalore Rifle Volunteers, has been promoted to 2nd-Lieutenant in that corps.

The medal for long service and good conduct was bestowed on Sub-Conductor W. Smith, (India Miscellaneous List), Draftsman, No. 6 Drawing Office, (Army Section).

The Volunteer Long Service Medal was bestowed on Messrs. H. W. Biggie, J. C. St. C. Pollett and R. C. Hanson.

11. The following table shows the distribution of officers during the year: the names of officers on deputation to local Governments are omitted. Several names occur more than once on account of transfers from one office to another:—

TABLE I—DISPOSITION OF OFFICERS, 1915-16.

SURVEYOR GENERAL OF INDIA—Colonel Sir Sidney G. Burrard, K.C.S.I., R.E., F.R.S.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Surveyor General's Office.	Major C. P. Gunter, R.E. Major L. C. Thuillier, R.A.			
No. 6 Drawing Office, Simla.	Lieut.-Colonel C. L. Robertson, C.M.G., R.E. Major C. J. Arbery	Mr. Asmat-ullah Khan, C.S. „ A. B. Hunter „ A. A. Graham		*5 European Draftsmen. 4 Printers. 23 Indian Draftsmen and Clerks.
Basrah Survey Party	Lieut.-Colonel F. W. Pirrie, I.A. Major H. H. Turner, R.E. Captain W. E. Perry, R.E.	Mr. J. McCraken „ B. T. Wyatt „ W. H. Strong „ A. J. Booth	Mr. Hamid Gul	22 Surveyors, &c.

SUPERINTENDENT, MAP PUBLICATION—*Lieut.-Colonel W. M. Coldstream, R.E. (Temporarily reverted to military duty).* Lieut.-Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Map Publication Office, Calcutta.		Mr. M. Gastaud		
No. 1 Drawing Office, Map Record and Issue Office and Engraving Office, Calcutta.	Major H. L. Crosthwait, R.E.	Mr. T. W. Babonau „ P. Williams „ M. C. Petters „ Jagdamba Prasad „ C. C. Byrne „ A. C. Bose „ P. Simpson „ P. N. Sur „ D. K. Rennick „ A. A. Graham „ Jiya Lal Sahgal		
Photo.-Litho. Office, Calcutta.	Major H. McC. Cowie, R.E.			
Mathematical Instrument Office, Calcutta.	Mr. T. A. Ferrier			
Bengal & Bihar & Orissa Drawing Office, (Imperial Standard Mapping Section).		Mr. E. G. Hardinge		

SUPERINTENDENT, NORTHERN CIRCLE—Colonel W. J. Bythell, R.E., up to 22nd November 1915. Lieut.-Colonel C. L. Robertson, C.M.G., R.E., from 23rd November 1915.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 3 Drawing Office, Mussoorie.		Mr. J. A. Freeman „ E. B. West		26 Draftsmen, &c.
No. 1 Party, *Kashmir and N. W. F. P.*	Major E. A. Tandy, R.E.	Mr. B. R. Hughes „ G. J. S. Rae „ P. A. T. Kenny „ R. C. Hanson	Mr. Sher Jang, K.B. „ Nathu Singh, B.S. „ Nanak Chand Puri, B.A. „ Jamna Prasad, B.S. „ Hamid Gul „ Jagdeesh Prasad Vastav—*Under training.*	38 Surveyors, &c.
No. 2 Party, *Punjab and Rājputāna.*		Mr. B. R. Hughes „ T. W. Babonau „ F. B. Powell „ Kanak Singh (Retired 21st March 1916) „ R. E. Saunders „ J. H. Johnson „ J. A. Calvert	Mr. Chuni Lal Kapur „ Ghulam Hasan—*Under training.*	30 Surveyors, &c.
No. 3 Party, *United Provinces.*		Mr. H. H. B. Hanby „ E. J. Biggie „ A. M. Talati „ H. T. Hughes „ G. E. R. Cooper „ Moqimuddin	Mr. Mahomed Lutf Ali „ Muhammad Husain „ Amir Abdul Salam Matlub Ahmad—*Under training.*	53 Surveyors, &c.
No. 4 Party, *United Provinces and Nepal.*		Mr. H. W. Biggie „ H. P. D. Morton „ J. C. C. Lears „ Dumi Chand Puri	Mr. Mohammad Husain Khan „ Daulat Ram Vohra—*Under training.*	28 Surveyors, &c.
No. 20 Party, *Peshāwar, Rāwalpindi, Bakloh, Jullundur, Sanāwar, Simla, (N. I. Lines). Kālka, Fort Lockhart, Hangu, Thal, Bannu, Jhelum, Sialkot, Upper and Lower Topa, Cherman and Nimach.*		Mr. A. Ewing „ O. D. Jackson	Mr. Dharma	23 Surveyors, &c.
Riverain Detachment, *Punjab.*		Mr. Maya Das Puri, B.S.	Mr. Paras Ram „ Lakshmi Dutt Joshi „ Vidya Dhor Chopra	74 Surveyors, &c. 6 Naib Tahsildars and Kanungoes, &c.
Simla Survey Detachment, *Simla.*		Mr. C. E. C. French „ F. C. Saint	Mr. Imam Din „ Jagdeesh Prasad Vastav „ Ghulam Hasan „ Amir Abdul Salam Matlub Ahmad „ Daulat Ram Vohra	7 Surveyors. *Under training.*

* Includes Army Section.

TABLE I—(Continued).—DISPOSITION OF OFFICERS, 1915-16.

SUPERINTENDENT, SOUTHERN CIRCLE—Colonel T. F. B. Renny-Tailyour, C.S.I., R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 4 Drawing Office, Bangalore.		Mr. J. H. Nichol „ F. P. Walsh „ P. R. Anderson	Mr. B. V. Narayana Rao	36 Draftsmen, &c.
No. 5 Party, *Berär, Central India and Central Provinces.*		Mr. J. O'B. Donaghey „ F. C. Pilcher	Mr. Damodar Khadilkar	19 Surveyors, &c.
No. 6 Party, *Bombay and Hyderābād.*	Major L. C. Thuillier, I.A.	Mr. P. R. Anderson „ P. Kennedy „ E. A. Meyer „ Haji Abdul Rahim, K.B. „ F. B. Kitchen „ Munshi Lal, B.A. „ M. S. Ganesa Aiyar „ J. C. St. C. Pollett „ K. S. Gopalachari, B.A.	Mr. Eknath Battu „ Ram Narayan Hastir „ Nabidad Khan „ Masud Khan	41 Surveyors, &c.
No. 7 Party, *Madras.*		Mr. W. M. Gorman „ S. F. Norman „ H. B. Simons „ V. W. Morton „ C. West „ H. H. P. Butterfield „ N. S. Harihara Iyer	Mr. Abdul Hakk, K.S. „ Kodandera Subbanna „ P. S. Venguswami „ Shib Lal „ H. Narasinhamurti Rao „ Shaikh Muhammad Salik „ E. N. Natesan, B.A. „ Pulin Behari Roy „ Jitendra Mohan Mukerji	40 Surveyors, &c.
No. 8 Party, *Madras.*		Mr. W. F. E. Adams „ M. Mahadeva Mudaliar, M.A.	Mr. Anantarao Dhondiba Mandhre, B.S. „ K. Narayanaswami Chetti	27 Surveyors, &c.
Training Section, *Mysore.*		Mr. S. S. McA'F. Fielding	Mr. Hari Ram Chandra Jogalekar „ G. K. Narasimha Ayyangar } *Under training.* „ K. R. Venkata Rao }	20 Surveyors, &c. and Pupils.

SUPERINTENDENT, EASTERN CIRCLE—Lieut.-Colonel R. T. Crichton, C.I.E., I.A.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 5 Drawing Office, Shillong.		Mr. P. J. Barrington, Retired 3rd July 1916 „ J. H. S. Wilson „ E. Claudius		22 Draftsmen, &c.
No. 9 Party, *Bengal.*		Mr. J. Smith „ Dhani Ram Verma „ E. M. Kenny „ Amar Krishna Mitra	Mr. Dalbir Rai „ Ram Singh „ Amulya Charan Ghosh } *Under training.* „ Gopal Lal Mitra }	26 Surveyors, &c.
No. 10 Party, *Upper Burma.*	Major E. T. Rich, R.E.	Mr. W. G. Jarbo „ H. B. Simons „ A. V. Dickson „ A. F. Murphy „ Dhirendra Nath Banerjee, L.C.E.	Mr. Hayat Muhammad, K.S. „ Maung Kyaw Nyein „ Dhirendra Nath Saha „ Ram Prasad, B.S.	27 Surveyors, &c.
No. 11 Party, *Upper and Lower Burma.*		Mr. J. O. Greiff „ O. J. H. Hart „ C. O. Picard „ A. J. Moore	Mr. Lachman Daji Jadu, B.S. „ Pratul Chandra Sen Gupta, B. Sc.—*Under training.*	28 Surveyors, &c.
No. 12 Party, *Assam.*	Lieut.-Colonel A. Mears, I.A.	Mr. Pramadaranjan Ray, B.S. „ B. C. Newland „ Prafulla Chandra Mitra, B.A. „ H. H. Creed	Mr. Girija Sonker Bagchi *Under training.*	42 Surveyors, &c.

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1915-16.

SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY—Colonel G. P. Lenox-Conyngham, R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Superintendent's Office.	*(Attached)* Colonel R. A. Wauhope, C.B., C.M.G., C.I.E., R.E.	Mr. H. A. Charrier	.....	
Computing Office	Mr. J. deGraaff Hunter, M.A.	Mr. Hanuman Prasad.....	Mr. Sarat Kumar Mukerji..... ,, Karuna Kumar Das, B.A.	63 Computers, &c.
No. 2 Drawing Office and Forest Map Office, Dehra Dun.	Major G. A. Beazeley, R.E.	Mr. T. W. Babonau ..... ,, O. C. Ollenbach ,, C. C. Byrne ,, H. C. W. Stotesbury ,, O. N. Pushong ,, F. C. Saint ,, Abdul Karim, B.A.	Mr. Lal Singh, R.B. ..... ,, Ram Singh, R.S. ,, Jamna Prasad, R.S.	
No. 13 Party,..... *(Astronomical).*	Colonel G. P. Lenox-Conyngham, R.E. Major H. H. Turner, R.E. Major G. A. Beazeley, R.E.	.....	.....	2 Computers, &c.
No. 14 Party,..... *(Pendulums).*	Colonel G. P. Lenox-Conyngham, R.E.	.....	.....	2 Computers, &c.
No. 15 Party,..... *(Triangulation).*	Mr. J. deGraaff Hunter, M.A....	Mr. L. Williams..... ,, G. A. Norman	Mr. Jugal Behari Lal.....	16 Computers, &c.
No. 16 Party,..... *(Tidal).*	.....	Mr. H. G. Shaw ..... ,, Syed Aulad Hossein, K.B. ,, Syed Zille Hasnain	.....	20 Computers, &c.
No. 17 Party,..... *(Levelling).*	.....	Mr. H. G. Shaw ..... ,, D. H. Laxa ,, T. F. Kitchen ,, Jiya Lal Sahgal ,, N. N. Chuckerbutty, L.C.E.	Mr. Karuna Kumar Das, B.A. ... ,, Satish Chandra Mukharji	11 Recorders, &c.
No. 18 Party, ... *(Magnetic).*	.....	Mr. E. C. J. Bond ..... ,, Rama Prasad Ray, B.A. ,, N. R. Mazumdar ,, Raj Bahadur Mathur, B.A.	Mr. Bidhu Bhusan Shome	3 Magnetic Observers. 14 Computers, &c.
No. 19 Party,..... *(Base Line).*	.....	Mr. Syed Aulad Hossein, K.B. ,, E. C. J. Bond ,, O. N. Pushong	.....	2 Computers, &c.
Exploration *In Central Asia with Sir Aurel Stein.*	.....	.....	Mr. Lal Singh, R.B.	1 Surveyor.

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PART 2.—WORK OF FIELD PARTIES, &c.

I.—TOPOGRAPHICAL SURVEYS.

12. The two following tables show respectively the progress of the topographical programme assigned to the department in 1905, and the out-turns and costs of different parties during the year under report. They are followed by brief descriptions of the work of each topographical party.

In 1913, the Secretary of State sanctioned a scheme for the reduction of the scale of survey of certain sparsely populated areas of India. This will greatly reduce the area of survey on the one-inch scale and consequently accelerate the rate of progress of topographical surveys shewn in Table H below. In order to give a better idea of what work actually lies before the department, it may be remarked that of the area remaining for survey about 620,000 square miles are likely to be surveyed on the half-inch or smaller scale.

Table II.—Progress of Topographical Surveys since 1905.

Survey year.	Scales of Survey.	Northern Circle.	Southern Circle.	Eastern Circle.	TOTALS.
		Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-06 ...	Mostly 2-inch and 1-inch	6,278	1,660	10,322	18,260
1906-07 ...	ditto ...	7,519	7,666	8,659	23,844
1907-08 ...	ditto ...	14,530	9,256	12,431	36,217
1908-09 ...	ditto ...	18,624	12,526	11,542	42,692
1909-10 ...	Mostly 1-inch ...	23,833	12,532	9,736	46,101
1910-11 ...	ditto ...	27,528	13,171	9,218	49,917
1911-12 ...	ditto ...	23,852	9,115	10,654	43,621
1912-13 ...	Mostly 1-inch and ½-inch	28,192	13,349	11,836	53,377
1913-14 ...	ditto ...	25,052	15,844	14,890	55,786
1914-15 ...	ditto ...	12,334	19,286	5,056	36,676
1915-16 ...	ditto ...	8,168	17,243	6,931	32,342
Total Areas completed to date ...		**195,910**	**131,648**	**111,275**	**438,833**
Approximate areas for the whole topographical programme.		**750,000**	**542,800**	**528,800**	**1,821,600**
Approximate areas remaining for survey.		**554,090**	**411,152**	**417,525**	**1,382,767**

Table III.—OUT-TURNS and COSTS of Topographical Surveys, 1915-16.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS. Areas on each Scale.	OUT-TURNS. Totals on all Scales.	COST OF SURVEY AND MAPPING. Total costs.	COST OF SURVEY AND MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	**NORTHERN CIRCLE.**
No. 1 Party—*Kashmīr, Jammu and North-West Frontier Province.*						
Open, partly cultivated, plain and barren hills.	4-inch Military Survey ...	64				
Wooded valleys and mountainous and rugged hills.	1-inch Survey	588	703	69,416 (a)	18·7	(a) Excludes Rs. 841 for Bikaner traverse and Rs. 619 for Tharoch Forest Survey or a total of Rs. 1,460 which will be recovered from the States concerned and refunded.
Ditto ditto	½-inch Revision Survey ...	51				
No. 2 Party—*Punjab and Rājputāna.*						
Sand hills with occasional rocky outcrops.	1-inch Survey	1,602	2,645	62,944 (b)	18·6	(b) Excludes Rs. 445 on account of cost of survey and mapping done for the Executive Engineer, Lower Bari Doab Canal, Balloke (Punjab), which will be refunded.
Ditto ditto	1-inch Revision Survey ...	1,043				
No. 3 Party—*United Provinces.*						
Open and wooded plains and wooded hills.	1-inch Revision Survey ...	2,152				
Wooded hills	2-inch Survey	391	3,088	1,10,384 (c)	32·2	(c) Includes Rs. 32,714 on account of cost of forest survey debitable to Rāmnagar and Kumaun Forests, United Provinces.
Ditto	4-inch Special Forest Survey ...	50				
Wooded hills and wooded plains ...	4-inch Supplementary Special Forest Survey.	495				
No. 4 Party—*United Provinces and Nepāl.*						
Densely forest-clad hills and fairly open plains.	1-inch Survey	180				
Fairly open plains	1-inch Resurvey	800	1,732	51,010	16·8	
Ditto	1-inch Revision Survey ...	802				
TOTALS, NORTHERN CIRCLE:—		8,168 sq. m.		Rs. 2,93,704	Cost-rate 21·6	
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	**SOUTHERN CIRCLE.**
No. 5 Party—*Berār, Central India and Central Provinces.*						
Forest-clad hills ...	2-inch Survey	64	64	15,259 (d)	238·4	(d) Excludes Rs. 15,420, cost of ½-inch mapping, but includes cost of triangulation.
No. 6 Party—*Bombay and Hyderābād.*						
Varied, mostly undulating ...	½-inch Survey	9,886				
Ditto ditto ...	1-inch Survey	1,261	11,177	1,31,724	11·8	
Rocky hills, wooded ...	1½-inch Survey	30				
No. 7 Party—*Madras.*						
Rocky hills and cultivated plains	1-inch Survey	5,227				
Forest-clad hills ...	1-inch Supplementary Survey ...	715	6,002	1,12,848	18·8	
Wooded hills and Madras City ...	2-inch Survey	60				
No. 8 Party—*Madras.*		Nil.	Nil.	20,034 (e)	Infinity	(e) Excludes Rs. 20,655, cost of ½-inch mapping, but includes cost of triangulation.
TOTALS, SOUTHERN CIRCLE:—		17,243 sq. m.		Rs. 2,79,865	Cost-rate 16·2	
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	**EASTERN CIRCLE.**
No. 9 Party—*Bengal.*						No detail survey was undertaken by this party.
No. 10 Party—*Upper Burma.*						
Mostly hilly and thickly wooded ...	½-inch Survey	300				
Ditto ditto ...	1-inch Survey	2,220				
Ditto ditto ...	1-inch Revision Survey ...	65	2,857	1,54,892	54·2	
Ditto ditto ...	½-inch Reconnaissance Survey ...	50				
Ditto ditto ...	2-inch Survey	222				
No. 11 Party—*Upper and Lower Burma.*						
Densely wooded hills and swamp vegetation.	1-inch Survey	1,882				
High hills densely wooded ...	2-inch Survey	285	1,795	1,22,697 (f)	68·3	(f) Excludes Rs. 15,394 on account of Maymyo Drawing Office but includes Rs. 18,296 for special forest survey debitable to Forest Department.
Ditto ditto ...	4-inch Special Forest Survey ...	128				
No. 12 Party—*Assam.*						
Densely wooded hills and open and high grass-covered plains.	1-inch Survey	1,805	2,279	1,32,761	58·3	(g) Includes 1·54 sq. miles of unreserved land.
Densely wooded plains and hills	2-inch Survey	474 (g)				
TOTALS, EASTERN CIRCLE:—		6,931 sq. m.		Rs. 4,10,350	Cost-rate 59·2	
GRAND TOTALS:—		32,342 sq. m.		Rs. 9,83,919	Cost-rate 30·4	

NORTHERN CIRCLE (*vide* index map No. 1).

13. No. 1 Party.—This Party surveyed an area of 639 square miles in the Udhampur district of Kashmīr and Jammu State. Of this area, 588 square miles were of new survey on the 1-inch scale and 51 square miles were revision of the published Atlas sheets. The reduced area of survey is due to the curtailment of programme of field work.

The country surveyed varied from 5,000 to 18,000 feet in altitude and consisted of well wooded valleys, above which lay glaciers and, in places, inaccessible cliffs.

An area of 64 square miles was surveyed in the Peshāwar district, (*vide* page 17).

14. No. 2 Party.—This Party surveyed a total area of 2,645 square miles on the scale of one inch equal to one mile in the districts of Hissār, Rohtak and Gurgaon of the Punjab and in the States of Jind, Pataudi, Dujāna, Alwar, Bikaner, Jaipur, Lohāru, Nābha, and Patiāla.

The country surveyed was undulating and was covered with sandhills and with occasional rocky outcrops.

In addition, triangulation and traversing of 1,260 square miles and 313 linear miles respectively were carried out for future half-inch detail survey in parts of Alwar, Bharatpur and Jaipur States.

The head-quarters of the party did not take the field.

15. No. 3 Party.—This Party surveyed an area of 3,088 square miles on all scales, in the Meerut, Bijnor, Morādābād, Almorā, Garhwāl and Nainī Tāl districts of the United Provinces and Rāmpur State (Rohilkhand). Of the above area, 2,152 square miles were revision survey on the 1-inch scale, 391 square miles comprised a 2-inch survey of reserved forests and contiguous areas, and 50 square miles were a special 4-inch forest survey. For future special forest surveys on scale 4 inches to a mile, 260 square miles were triangulated, and 512 linear miles traversed in advance. 454 linear miles and 485 square miles were also traversed and triangulated respectively, in advance, for future 1-inch survey. A supplementary survey was also carried out over an area of 495 square miles, in the Rāmnagar Forest Division (Western Circle).

The southern half of the area surveyed is practically flat, except for the presence of a series of low sandy ridges; dense forest growth was met with along the foot-hills of southern Garhwāl, and in parts of the Kāshipur *tahsīl* and Bhābar, of district Nainī Tāl. The northern half consists of densely forest-clad and intricate hills, the greater part of which is reserved forests.

16. No. 4 Party.—Two detachments of this Party surveyed a total area of 1,732 square miles on the scale of 1 inch to 1 mile in the Azamgarh, Fyzābād, Gorakhpur, Bastī, Jaunpur, Sultānpur and Bahraich districts of the United Provinces, and in Nepāl State. The area in the United Provinces consists of flat plains which are well cultivated. Orchards containing mango trees are numerous, but there are no forests, though scrub growth occurs in some places. Village sites are numerous. The Gogrā river runs through a portion of the area that came under survey.

The area in Nepāl State, slightly over 100 square miles, lies in the *tarai* along the border of the Bahraich district, and consists of fairly open plains and low hills very densely clad on their lower slopes, the summits and upper slopes being covered in spear-grass.

In addition, an area of 107 square miles of triangulation was done in Nepāl to enable the detail survey to be carried out.

17. Recess Work.—Of the current and previous season's survey the fair mapping of 35 sheets for publication on the 1-inch scale and of 2 for publication on that of ½-inch, remain for completion on 30th September 1916; also that of 7 sheets of forest surveys for publication on the 2-inch scale.

Nos. 1, 2, 3 and 4 Parties have dealt during the year with 33 half-inch sheets drawn from published modern one-inch sheets, and of these, 7 sheets have been sent for publication. These numbers are additional to those of sheets dealt with, and sent for publication, by the Circle Drawing Office.

18. The cost-rates given in Table III against the parties of the Northern Circle have been based on detail survey and mapping of all kinds carried out during the year under report and on triangulation and traversing partly of previous seasons and partly of the current one. They have been swelled by the inclusion, in the expenditure of the parties, of the cost of carrying out the fair mapping of the Basrah Survey Party.

19. Particulars of further special work done by No. 2 Party is given on page 40, and of that done by No. 1 Party, No. 20 Party (Cantonment), the Punjab Riverain Detachment and the Simla Survey Detachment on pages 17 to 19.

SOUTHERN CIRCLE (*vide* index map No. 2).

20. No. 5 Party.—This Party surveyed an area of 64 square miles of reserved forests in the Buldāna district of Berār and in the Nimār district of the Central Provinces, and triangulated an area of 3,853 square miles in the Bhopāl, Dhār and Indore States of Central India and in the Betūl, Hoshangābād and Nimār districts and the Makrai State of the Central Provinces. The country surveyed consists of wooded hills. The majority, including the head-quarters, of the party remained at Bangalore throughout the year and was principally employed on the fair-drawing of half-inch sheets compiled from one-inch maps.

21. No. 6 Party.—This Party surveyed an area of 11,177 square miles in the Ahmadnagar and Sholāpur districts of Bombay and in the Aurangābād, Bhīr, Bidar, Nānder, Nizāmābād, Osmānābād, and Parbhani districts of Hyderābād, and triangulated an area of 13,961 square miles in the Bijāpur and Sholāpur districts and the Akalkot State of Bombay and in the Atrāf-i-balda, Bidar, Gulbarga, Mahbūbnagar, Medak, Nalgonda and Osmānābād districts of Hyderābād. The country surveyed is of a varied nature, rising abruptly from the Godāvari river into a range of rocky hills which slope away gently southwards to the well populated and undulating plains of the basins of the Bhīma and Mānjra rivers. The greater portion of the area surveyed is in Hyderābād and was mostly surveyed on the half-inch scale.

22. No. 7 Party.—This Party surveyed an area of 6,002 square miles in the Chingleput, Chittoor, Cuddapah, Madras, Nellore and North Arcot districts of Madras, and triangulated an area of 10,041 square miles in the Cuddapah, Guntūr, Kurnool and Nellore districts of Madras. The country surveyed includes portions of the Eastern Ghāts and of the cultivated plains of Madras along the sea coast. The confused hill system of the Eastern Ghāts consists of fairly high forest-clad hills, of lower rocky hills devoid of vegetation and of detached hills with low expanses of cultivation between them.

23. No. 8 Party.—This Party triangulated an area of 3,825 square miles in the Tinnevelly and Rāmnād districts of Madras. The country triangulated was very flat and was intersected by a net work of bunds, dykes, supply channels and tanks, dense groves of trees surrounded many of the villages. The majority, including the head-quarters, of the party remained at Bangalore throughout the year and was principally employed on the fair-drawing of half-inch sheets compiled from one-inch maps.

24. Training Section.—This Section took the field in the Kolār district of Mysore. 19 pupil surveyors received instruction in topographical surveying.

25. Recess Work.—The whole of the area surveyed this year by the Southern Circle should be fair-drawn by the end of 1916.

EASTERN CIRCLE (*vide* index map No. 3).

26. No. 9 Party.—This Party traversed an area of 1,504 square miles in the Burdwān, Hooghly, Nadiā and Jessore districts in advance of detailed topographical survey. 2,707 points such as trees, temples, &c., were fixed by intersection with the theodolite from 1,589 stations along 682 linear miles of traverse. The traverse work was based on stations of the Calcutta Meridional Series of the Great Trigonometrical Survey. The country is flat and featureless except for the numerous *bils* and rivers that intersect it in all directions.

No detail survey was undertaken by the party during the year, but the greater portion of it was employed on half-inch mapping at Shillong.

27. No. 10 Party.—No. 10 Party surveyed an area of 2,857 square miles in the Kathā, Upper Chindwin, Myitkyinā and Putao districts of Upper Burma and the Tavoy and Mergui districts of Lower Burma, including 350 square miles in unadministered territory of which 50 square miles were reconnaissance survey, 2,000 square miles were triangulated in the Myitkyinā and Putao districts.

The country surveyed in Upper Burma consisted of thickly wooded hills rising over 4,000 feet above sea level and cut up by numerous low lying valleys.

In Lower Burma the country surveyed lay between the sea coast and the main range forming the western watershed of the Tenasserim river, together with a number of islands lying off the coast. It varied from the steep densely wooded hills along the Tenasserim watershed which were over 6,000 feet high, practically uninhabited, and with no communications, to the flat alluvial land covered with villages nearer the sea, whilst the sea coast was everywhere fringed with mangrove swamps.

28. No. 11 Party.—No. 11 Party surveyed, on the 1-inch scale, in the districts of Tavoy and Mergui, Lower Burma, an area of 1,312 square miles, specially required by the Burma Government, in connection with the Wolfram Mining Industry. 580 square miles were triangulated in the Mergui district. In the districts of Mandalay and Kyaukse, and the Northern Shan States, Upper Burma, an area of 483 square miles was surveyed. Of this area 70 square miles were surveyed on the 1-inch scale for the preparation of the Artillery Practice Camp Map, required by the General Staff, Burma Division: 285 square miles were of 2-inch survey, and 128 square miles special 4-inch scale survey, of reserved forests. The country surveyed varied in elevation from sea level in Mergui to 4,800 feet in Upper Burma, and was almost entirely covered with dense forest growth, and grass jungle, which made progress slow and difficult.

29. No. 12 Party.—No. 12 Party surveyed an area of 2,279 square miles on all scales in the Sibsāgar, Lakhimpur, Nāgā Hills and Darrang districts of Assam and carried out 884 linear miles of traversing. Of the above area 472 square miles comprised a 2-inch scale survey of reserved forests. The country under survey consists mainly of the alluvial plains of the Brahmaputra valley and a small portion of the Nāgā Hills which are densely wooded. In the plains considerable areas are devoted to the growing of tea and paddy; where not under cultivation the country is a mass of tree, cane and high grass jungle and is to a large extent flooded throughout the rainy season.

30. Recess work.—There were no arrears of mapping of the previous season's survey on 30th September 1916 but of the current season's survey 5 sheets remain to be completed as regards contours only.

Nos. 9 and 11 Parties have dealt with 49 half-inch sheets prepared from one-inch modern published sheets; 20 of these have been sent for publication. These numbers are additional to those being dealt with by the Circle Drawing Office. At the end of the year there were 39 sheets not yet taken up for which material (*i.e.*, modern published 1-inch sheets) is available.

II.—FOREST SURVEYS.

31. During the year 1915-16, the forest surveys have, as usual, been carried out by the topographical parties of the Survey of India. In the majority of cases the surveys were executed on the scale of 2 inches to the mile, but in some few instances the work was done on the 4-inch and 1-inch scales.

NORTHERN CIRCLE.

32. Western Circle, United Provinces (*Rāmnagar Forest Division*).—28 printed sheets of this division were revised, and roads, boundaries, &c., inserted; the area dealt with was 495 square miles.

33. Kumaun Circle, United Provinces (*Naini Tāl District Forest Division*).—48·307 square miles of reserved forests were surveyed on the 4-inch scale, this area comprised the Kosi forest range and the Mahrora block of the China forest range. Latauli forest was also surveyed, for the Imperial Bacteriologist, on the 4-inch scale, area 1·4 square miles.

137 square miles were triangulated for future surveys on the 4-inch scale.

505 linear miles were traversed in connection with the Naini Tāl district forests, for survey on the 4-inch scale.

(*Southern Garhwāl Division*).—158 square miles were surveyed on the 2-inch scale.

SOUTHERN CIRCLE.

34. Central Provinces (*Berār Circle*).—Five reserved forests, of a total area of 54 square miles, were surveyed on the 4-inch scale; a skeleton plane-table boundary survey of the outer boundaries, on the 4-inch scale, was also carried out.

The reserved forests surveyed are known as, Partabpur, Gogaipur and Jholpura-Dongarla, of the Nimār forest division, and Raipur block and Ambābārwa of the Buldāna forest division.

The detail and boundary surveys were carried out by plane-table interpolation and traversing, based on points fixed trigonometrically.

Trigonometrical heights were supplemented by heights obtained from observations taken with the clinometer.

35. Madras Presidency.—Seven reserved forests comprising a total area of 29·34 square miles were surveyed, on the 2-inch scale, by No. 7 Party, during the year. The names of the forests are as follows:—

Satyavedu and Ambakkam reserves in district Chingleput; Chittapāra Extensions A and E, B, C, and Basavāpalli Extension B, in Chittoor district; Thunakonda reserve in Cuddapah district.

Plane-table traversing was resorted to for main streams and forest boundaries, but interpolation based on trigonometrical points was obtainable everywhere.

EASTERN CIRCLE.

36. Upper Burma (*Northern Forest Circle*).—No. 10 Party surveyed the Indawgyi, Namma and part of the proposed Mokso reserves in the Myitkyinā division, and the Namaw and Nankobin reserves in the Mansi division, amounting to 222 square miles, on the 2-inch scale.

37. Upper Burma (*Southern Forest Circle*). (*Mandalay Division*).—No. 11 Party carried out the detail survey of the Baw and Baw Extension reserved forests on the special scale of 4 inches to the mile. The total area surveyed was 128 square miles, the cost, Rs. 18,296, is debitable to the Forest Department. In addition to the above, 116 square miles of survey on the 2-inch scale of the reserved forests of Taungbyo, Sakangyi, Zibingyi-Tonbo, Kywetnapa and Nyaungdauk, were carried out thus completing the survey of the forest areas round Maymyo and environs.

(*Meiktila Division*).—Detail survey on the 2-inch scale of a part of the reserved forest of Ye-amen, comprising an area of 169 square miles, was also undertaken; but the work was not completed owing to the party having to undertake special surveys in Mergui, in connection with the Wolfram Mining Industry.

(*Tenasserim Division.*).—A total area of 128 square miles, in the reserved forests of Kaleinaung, Heinze and Panadaung, was surveyed on the 1-inch scale as part of the 1-inch programme of topographical surveys.

38. Assam.—No 12 Party carried out, in the course of ordinary topographical operations, the survey on the 2-inch scale of the Nāmbar (balance), Rengmā, Diphu, Daiang (balance), Kākadangā, Desai Valley, Disai and Holongapar reserves, embracing an area of 472 square miles. In addition, in the *Nāmbar* reserved forest, only that portion of the area thrown open for settlement (situated between the Horupani-Nāojān road and latitude 26° 15′ 0″) was surveyed on the 1-inch scale, the Forest Department being of the opinion that this scale would meet all requirements.

The exterior artificial boundaries of the following reserves in the Sibsāgar and Lakhimpur districts, amounting to 128 linear miles, were traversed by theodolite on the 4-inch scale:—

Nāmbar (part), Disai, Holongapar, Abhaipur, Panidihing, Diroi and Dihingmukh.

The Sola reserved forest could not be traversed owing to a change in the position of its boundary which had not been demarcated, and the Jokai reserved forest was not traversed owing to bad weather.

39. Andaman Islands.—No forest surveys were carried out in the Andamans during the year under report.

III.—CANTONMENT AND LARGE-SCALE SURVEYS.

40. No. 1 Party.—During the year under report a detachment was employed on the survey of an area of 64 square miles on the scale of 4 inches to a mile near Shabkadar, in the Peshāwar district.

The country surveyed consisted of open, partly cultivated, plain, and barren hills.

The map was drawn in 3 sheets and was sent for publication.

The total cost was Rs. 11,486, and the cost-rate per square mile of survey and mapping was Rs. 179·5.

41. No. 20 Party (Cantonment).—During the year under report the Party was employed on the survey of the cantonments and military stations of Peshāwar, Rāwalpindi, Bakloh, Jullundur, Sanāwar, Simla (Native Infantry Lines), Kālka, Fort Lockhart, Hangu, Thal and Bannu on scale 16 inches to a mile; and on that of the bazars of Peshāwar, Rāwalpindi, Bakloh, Jullundur, and Bannu on scale 64 inches to a mile. The triangulation and traversing of Rāwalpindi, Fort Lockhart, Hangu and Thal was completed during the year; and Jhelum, Siālkot, Upper and Lower Topa, Chaman and Nimach have been traversed in advance for season 1916-17.

Forty-two sheets of fair maps have been sent to Dehra Dūn for publication, and thirty are in hand, and will be completed and sent for publication by May 1917.

The proposed programme for the ensuing year is the completion of the detail survey of Rāwalpindi Cantonment and the execution of that of the cantonments and military stations of Jhelum, Siālkot, Topa, Drazinda, Jandola, Jatta, Zām, Chitrāl, Upper Drosh and Lower Drosh, also the triangulation and traversing in advance of Nasīrābād, Deoli and Jhānsi. There may be changes in the programme as it will be impossible to predict what the political condition will be on the Frontier when the survey of Chitrāl, Upper Drosh, Lower Drosh, Drazinda, Jandola, Jatta and Zām has to be done.

Out-turn and cost-rates of Cantonment Surveys, 1915-16.

Cantonments.	Scales.	Out-turn in acres.	Total cost. Rs.	Cost-rates per acre for survey and mapping. Rs.
Peshāwar, Rāwalpindi, Bakloh, Jullundur, Sanāwar, Kālka, Fort Lockhart, Hangu, Thal and Bannu ...	16"=1 mile	18,958	48,209·25	2·54
Peshāwar, Rāwalpindi, Bakloh, Jullundur and Bannu ...	64"=1 mile	343	4,809·00	14·02
Simla (Native Infantry Lines) ...	125 feet=1 inch	1	467·00	467·00
		19,302	53,485·25	

Alphabetical List of Cantonments and Military Stations surveyed and published in modern style, on the scale of 16 inches = 1 mile, up to 1915-16.

(1) Dehra Dūn Cantonment.
(2) Guna do.
(3) Hāpur (Babugarh) Remount Depôt.
(4) Kālka Cantonment.
(5) Kamptee do.
(6) Landour do.
(7) Meerut do.
(8) Quetta do.
(9) Quetta Civil Station.
(10) Rājkot Cantonment.
(11) Sahāranpur Remount Depôt.
(12) Sanāwar Cantonment.
(13) Saugor do.

42. The Punjab Riverain Detachment.—The Detachment continued the work of traversing, and laying down base lines. 155 linear, and 459 square miles of main circuits; and 751 linear, and 100 square miles of minor traverses were run; and 261 theodolite stations of the former and 4,170 of the latter, were fixed in the area under water action of the rivers Indus, Sutlej, Beās, and Chakki in Bahāwalpur State, and districts Dera Ghāzi Khān, Ambāla, Hoshiārpur, Kāngra, and Gurdāspur. 162 corners of 54 squares, and 48 traverse stations were demarcated in 100 square miles with permanent mark-stones on both banks of the Beās, and the Chakki in districts Kāngra, Hoshiārpur, and Gurdāspur to serve as bases for the future survey and demarcation of boundaries and fields in the bed of the rivers. 852 plotted, and 142 boundary *masāvis* (settlement mapping sheets) on the scales of $\frac{1}{2,640}$ (Ambāla), and $\frac{1}{2,500}$ (Kāngra), and 8 four-inch sheets were traced, and supplied in time to the Settlement Officers. Besides these 108 miscellaneous traces were prepared, and all the traverse stations marked during the year were plotted on 8 four-inch sheets. 504 *masāvis* of 106 *tikās* (sub villages) of districts Kāngra and Hoshiārpur were reduced with a pentagraph, 5 riverain boundary sheets were compiled, and 16 sheets typed on the scale 4 inches to a mile.

43. *The Kāngra Special Survey* was started on the 18th October 1915 under the usual conditions, in continuation of the last season's programme. 2,162 linear, and 300 square miles of the district area, were traversed, and triangulated; and 12,067 stations were fixed with theodolite in 575 *tikās* (sub villages). 3,542 plotted *masāvis* of 792 *tikās*, on the scales of 20, 40, and 80 *karams* (one *karam*=57·5 inches) to an inch, and 17 traces on the scale of 4 inches to a mile, were supplied to the Settlement Officer, Kāngra. Besides these 56 miscellaneous traces were prepared, and all the traverse stations marked during the year were plotted on 22 four-inch sheets. The riverain work done in the Kāngra district on the Beās is given in para. 42.

44. *The Simla work* was commenced in the Kotgarh tract on the 2nd October, and was closed on the 30th November 1915. 1,066 linear, and 15 square miles were traversed, and triangulated; and 1,153 stations were fixed with theodolite. 256 plotted *masāvis* of 70 villages on the scale of 40 *karams* (one *karam* = 54 inches) to an inch, and 2 four-inch sheets were traced, and supplied to the Settlement Officer, Simla. Besides these 4 other miscellaneous sheets were prepared, and all the traverse stations marked during the year were plotted on one four-inch sheet.

45. At the special request of the Deputy Commissioner, Attock (Campbellpur) the *Khaur Special Survey* was taken up for the Attock Oil Company. Four adjoining squares, each of an area of 1 square mile, constituting the Government concession to the Company, were demarcated, and the contained area traversed and then surveyed in detail on the scale of 8 inches = 1 mile. The hills were sketched, and no regular contours were shown. The map was then traced, fair-drawn, and supplied to the Company within 3 months.

46. *The Kāngra Road Survey* was carried on in continuation of the last year's programme with the object of avoiding boundary discrepancies as compared with the settlement maps. 41·6 miles of road, from mile No. 7 to mile No. 48·6, were surveyed. 556 points were fixed with theodolite, and 44 linear miles traversed. 63 sheets of the last year's work, and copies of the *khasrās* (records of rights) were completed, and supplied to the Executive Engineer, Provincial Division, Kāngra. The work surveyed this year is being plotted, and the sheets will be supplied to the Executive Engineer during the coming season.

47. With a view to test the area of grass land the *Lahore Cantonment Boundary Survey* was undertaken at the request of the Cantonment Magistrate, Lahore. In all 22 linear miles, containing 70 theodolite stations were traversed in 1,472 acres; and the boundaries of 8 plots of 1,190 acres surveyed. A trace of the map, on the scale 12 inches to a mile, showing the boundaries, areas, &c., was supplied to the Cantonment Magistrate, Lahore.

48. Simla Survey Detachment.—By the end of March 1916 the remnants of the field work had been completed, and the Detachment proceeded to Mussoorie to carry on the mapping. The fair drawings have been prepared with a view to the production of two separate sets of maps, to meet special and general requirements.

These are now nearing completion and it is hoped will be completed by the end of November 1916. The detachment will cease to exist from 12th October 1916.

IV.—TRIGONOMETRICAL SURVEYS.

GEODETIC OPERATIONS.

49. No. 13 Party.—Astronomical Latitudes.—No latitude operations were undertaken, there being no officer available. The establishment of the party was employed at head-quarters chiefly on the preparation of Triangulation data for publication in pamphlet form.

Some progress was made in the marking of the Longitude Stations by means of suitably inscribed slabs.

50. No. 14 Party.—Pendulum Observations.—No observations were made, as no officer was available. The establishment of the party was employed at head-quarters.

51. No. 15 Party.—Triangulation.—No. 15 Party did not take up any new series of triangulation during the year, but a detachment was employed in revising the southern triangle of the Manipur Meridional Series.

The observations of this series were completed in 1902 but the three southernmost stations, which formed the connection with the Burma Coast Series, were observed at late in the season under unfavourable conditions and the last triangle exhibited a large error. The revision of the observations was important as it was necessary to ensure a satisfactory connection before the adjustment of the Burma triangulation was taken up.

Altogether four stations were re-observed with T. and S.'s 12-inch Theodolite No. II and a satisfactory connection made. During the course of the revisionary work two astronomical azimuths and two latitudes were also observed at the following stations:—

Station.	Latitude.	Longitude.	Height in feet.
Yeponetaung H. S.	20°-15′	93°-42′	2,819
Retkamauk H. S.	19°-48′	93°-28′	1,585

52. No. 16 Party.—Tidal Operations.—During the year under report tidal registrations were carried out by means of self-registering tide-gauges at the stations given in the following list:—

	Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.		Remarks.
1.	Aden	1879 ...	Still working	37		
2.	Karachi ...	1868 ...	1880	*13	49	*With a small tide-gauge.
		1881 ...	Still working	36		
3.	Bombay (Apollo Bandar)	1878 ...	,,	38		
4.	Bombay (Prince's Dock)	1888 ...	,,	28		
5.	Madras ...	1880 ...	1890	10	31	
		Restarted 1895	Still working	21		
6.	Kidderpore	1881 ...	,,	35		
7.	Rangoon	1880 ...	,,	36		
8.	Moulmein ...	1880 ...	1886	6	13	
		Restarted 1909	Still working	7		
9.	Port Blair	1880 ...	,,	36		

In addition to the above work, the Port Officers of Bhaunagar, Chittagong and Akyab supplied the actual record of high and low water obtained from tide-pole readings taken during day-light at those ports.

Tidal registrations at the 9 observatories now working have, on the whole, been carried out satisfactorily and will be continued during the coming year.

All the above observatories were inspected during the year under report.

53. In the following table are given the annual and decadal percentages of errors in the predicted times and heights of high and low water at all the stations where observations have been taken by self-registering tide-gauges :—

PERCENTAGE OF ERRORS IN PREDICTED TIMES AND HEIGHTS.

YEAR.	AT OPEN COAST STATIONS.							AT RIVERAIN STATIONS.						
	Number of stations.	In Time. Within 15 minutes of actuals.		In Height. Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.		Number of stations.	In Time. Within 15 minutes of actuals.		In Height. Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H.W.	L.W.	H.W.	L.W.	H.W.	L.W.		H.W.	L.W.	H.W.	L.W.	H.W.	L.W.
1906	6	85	81	96	97	94	95	2	59	53	74	64	92	95
1907	6	84	83	98	98	98	99	2	58	47	78	60	96	90
1908	6	84	84	98	97	99	99	2	58	52	77	60	97	92
1909	6	85	86	97	97	97	98	3	61	59	69	65	93	92
1910	6	81	83	98	98	95	96	3	57	52	63	71	89	94
1911	6	84	84	98	99	97	98	3	65	51	68	66	90	90
1912	6	82	82	97	98	97	98	4	70	58	74	62	94	91
1913	6	83	82	97	97	98	99	4	68	55	70	58	94	88
1914	6	77	79	96	97	98	98	3	75	67	71	55	92	84
1915	6	82	82	98	98	96	96	3	76	66	73	67	94	92
Average of ten years	...	83	83	97	98	97	98	...	65	56	72	63	93	91

54. No. 17 Party.—Levelling.—Four detachments were employed on levelling operations during the past season.

The out-turn amounted to 828 miles including branch lines as detailed below. This includes 24 miles in Bahāwalpur State, 24 miles in Dholpur State and 53 miles in Gwalior State.

(a).—In the Punjab.

From Ambāla *via* Karnāl to Singhū along the Grand Trunk Road. This forms part of the line which was carried on to Delhi.

From Jhang *via* Fāzilka, Mandi Dabwāli, Sirsa, Hissār, and Rohtak to Bahādurgarh by road, crossing the Sutlej and Rāvi rivers en route. This line was carried on to Delhi.

The above lines traverse numerous canals and large irrigated tracts in this Province and will furnish additional data for irrigation and other purposes.

A branch line from Fāzilka to Amruka, which was continued to Sādikganj (Bahāwalpur State), was run in order to strengthen the connection of the Standard bench-mark at Sādikganj. The original connection made in 1909-10 was with one old bench-mark only. This was considered unsatisfactory, and was rejected.

(b).—In the Delhi Province.

From Singhū along the Grand Trunk Road to Delhi. This is part of the line which starts from Ambāla *via* Karnāl.

From Bahādurgarh to Delhi along the Rohtak-Delhi road. This line is a continuation of the portion from Jhang *via* Fāzilka, Hissār and Rohtak to Bahādurgarh

(c).—In the United Provinces.

Revision of the following lines:—

From Somna to Alīgarh along the Grand Trunk Road and thence along the main road to Agra.

From Agra to the Bāngangā river. This line was carried on to Gwalior *via* Dholpur along the Agra-Bombay Trunk Road.

The above lines were originally levelled in 1861-62.

From Lucknow *vid* Unao to Cawnpore by road. This line was originally levelled in 1868-69.

55. No. 19 Party.—Base Line Operations.—Owing to the deficiency of officers in the department, caused by the war, no Base Line work was undertaken during the year.

56. *Traverse of the Boundary of the Imperial Delhi Area.*—A small detachment was formed to run a traverse along the boundary of the Imperial Delhi Area, on the west side of the Jumna river. This was undertaken at the request of the Chief Engineer, Public Works Department, Delhi, for the accurate determination of the bearings and lengths of the 775 links into which the boundary, which is about 30 miles in length, is divided. In addition to this the 200 pillars which demarcate the thirteen unacquired portions of land termed "Islands" were connected to the traverse.

Before running the traverse a piece of triangulation, based on the side Pir Ghaib H. S.—Tāl Katora h. s. of the Great Arc Meridional Series, was carried out for the purpose of fixing suitable points for the control of the traverse of the boundary and "Islands".

57. *Work during recess season.*—The detachment was employed during the recess season on the computation of the triangulation and traverse.

MAGNETIC SURVEY.

58. No. 18 Party.—Magnetic.—The three magnetic observatories, Dehra Dūn, Kodaikānal and Toungoo have continued in operation throughout the year.

The observatories were inspected by the officer in charge during the field season and a complete set of observations at each was taken by him for the yearly comparison of instruments. The Alībāg observatory was also visited for comparative observations.

59. *Transfer of the Kodaikānal observatory.*—It has been deemed advisable to place the Kodaikānal observatory under the control of the Meteorological Department, for a better supervision of the work of the observatory than is possible at so great a distance from the Survey Head Quarters at Dehra Dūn. With the approval of the Director General of Observatories and the sanction of the Government of India, the magnetic observatory and the observatory staff were transferred to the Meteorological Department on the 1st August 1916. The Director of the Kodaikānal observatory will continue to send the periodical returns of magnetic observations as usual, in original and duplicate, to the Officer in charge of No. 18 Party for the computation of the reduction of the observations and for record.

60. *Field work.*—Since the repeat stations of the Magnetic Survey will be visited for magnetic observations at intervals of 5 years only, no field observations were taken during the year. It was however, necessary for a detachment to proceed to Delhi to select a suitable site for a new repeat station, as the "Bela" land, on which the old site was situated, was being dug up under a scheme for grading the bank of the Jumna river. Comparative observations were taken by two observers at both the old and new sites, before the former was destroyed, to ensure a continuity of record for the determination of reliable secular change values for the locality.

61. *Work during recess season.*—The computation and tabulation of the Declination, Dip, Horizontal Force and Vertical Force for the three survey base stations (Dehra Dūn, Kodaikānal and Toungoo) for 1915 have been completed; the mean values of these elements for the year 1915 derived from all available days, excluding those of great disturbance, are given in the table below. From the beginning of 1915 the present values of the moments of inertia and the revised values of the distribution co-efficients have been used to determine the values of the Horizontal Force, consequently the values in these tables cannot be compared with the values published in previous years. Values, revised as above, for 1914 are included in the table below for comparison.

62. *Reduction of observations to epoch.*—The final reductions of the magnetic observations to the selected epoch have been proceeded with throughout the year and are making good progress. The reduction of the declinations at all field stations to that epoch is nearing completion and will it is expected be ready by the end of the year.

Mean values of the Magnetic Elements at Observatories.

Observatory.	Latitude & Longitude.	1915.				1914.	
		Dip.	Declination.	Horizontal Force.	Vertical Force.	Horizontal Force.	Vertical Force.
	° ′ ″	° ′	° ′	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Dehra Dūn ...	30 19 19 N 78 3 19 E	N 44 30·6	E 2 15·5	·33083	·32522	·33134	·32427
Toungoo ...	18 55 45 N 96 27 3 E	N 23 7·2	W 0 3·1	·39005	·16653	·38965	·16621
Kodaikānal ...	10 13 50 N 77 27 46 E	N 4 17·0	W 1 22·3	·37614	·02817	·37604	·02753

PART 3.—OFFICE WORK.

I.—HEAD QUARTER OFFICES.

MAP PUBLICATION OFFICE (*vide* Index maps at end).

63. The classes of maps for the publication of which the Head Quarter Offices are responsible, are as follows:—

(*a*)—Topographical maps on the scale of 1 inch to 1 mile.

(*b*)—Topographical maps on the scale of ½ inch to 1 mile.

(*c*)—Topographical maps on the scale of ¼ inch to 1 mile.

(*d*)—Geographical maps on the one-millionth scale (about 1 inch to 16 miles).

(*e*)—Geographical maps on the two-millionth scale (about 1 inch to 32 miles).

(*f*)—General maps on small scales.

(*g*)—Special maps.

64. *(a)* **Topographical maps on the scale of 1 inch to 1 mile.**—During the year 128 modern sheets have been received for publication and 204 have been published. The corresponding figures for the previous year being 207 and 154 respectively. The decrease in the former figure being due to smaller field outturn and the increase in the latter figure being due to the increased machine power now available.

Putting aside the sheets surveyed in Kashmir where the season of field survey differed from that in other parts of India, the one-inch maps of all areas surveyed up to 30th September 1914 have been published. Of the sheets surveyed up to 30th September 1915, 47 remain to be published.

Index maps Nos. 4—6 at the end of this report show the progress made in the publication of the modern one-inch sheets and the table below gives the annual output of sheets since the modern topographical surveys were begun:—

Year.	Number of 1-inch Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1906-07	4	1	...	5
1907-08	16	15	22	53
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
1911-12	68	33	58	159
1912-13	104	60	58	222
1913-14	71	38	49	158
1914-15	97	18	9	154
1915-16	**85**	**69**	**50**	**204**
Total Published ...	603	383	408	1,394
No. of 1-inch sheets which will not be published whose area is covered by published ½-inch sheets ...	...	14	...	14
Approximate number of 1-inch sheets in India ...	2,160	2,067	2,101	6,328
Approximate number remaining for publication ...	1,557	1,670	1,693	4,920

In addition to the above outturn of modern one-inch sheets, 26 sheets prepared from modern revenue surveys have been received for publication, and 27 published as preliminary editions pending their topographical revision at some future date (*vide* Index maps No. 7 and No. 8); special editions of 19 modern one-inch sheets have been published at the request of Local Governments to show village boundaries.

To maintain stocks or to give effect to important changes due to the development of communications, 27 modern one-inch and 43 old style sheets on various scales have been reprinted. The increase in the reprints of modern one-inch sheets is becoming marked, 6, 12, and 27 in the last three years; this increase will naturally continue and will add considerably to the work of the Photo.-Litho. Office.

65. *(b)* **Topographical Maps on the scale of ½ inch to 1 mile.** (*Vide* Index map No. 9).—In addition to the areas which are being surveyed and published on the ½-inch scale, of which 4 sheets have been published this year making a total of 5 sheets, half-inch maps are also being prepared of all those areas already published on the 1-inch scale. 21 such sheets have been published and 60 are under publication, this branch of publication is therefore in full swing.

66. *(c)* **The map of India on the scale of ¼ inch to 1 mile.** (*Vide* Index map No. 10).—This map is prepared in "degree sheets" which include $1° \times 1°$, or the area covered by 16 one-inch sheets.

The following table shows the progress made in publication:—

Years of Publication.	Number of Degree Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1911-12	2	1	4	7
1912-13	3	1	1	5
1913-14	4	3	2	9
1914-15	1	3	3	7
1915-16	.....	**1**	**4**	**5**
Totals	10	9	14	33
Approximate number of degree sheets in India	170	140	140	450

The number of these sheets received for publication has been much reduced since the introduction of the half-inch sheets Pending the preparation of new degree sheets from modern surveys, 28 degree sheets have been published during the year as Provisional Issues; these are merely extracts from the engraved Atlas sheets, which will gradually be superseded, brought up to date as far as possible; consequently only 72 reprints of Atlas sheets were published during the year as compared to 137 in the previous year.

67. *(d)* **Geographical Maps on the one-millionth scale,** (about 16 miles to 1 inch). (*Vide* Index map No. 11).—During the year 6 new sheets of this series and engraved editions of three were published; the remainder should be published shortly. As the publication of this series has extended over many years, during which time constant improvements have been introduced, opportunity will be taken, when new editions are necessary, to make the whole series uniform, they can then be joined together when required or form a basis for Provincial maps. Several of these sheets are also being engraved.

68. *(d)* **La Carte Internationale du Monde au 1,000,000:—** (*Vide* Index map No. 12). A full description of the genesis of this series was given in the General Report for 1913-14. One sheet No. N. F. 42 has been published during the year.

69. *(e)* **Geographical Maps on the two-millionth scale** (about 32 miles to 1 inch). (*Vide* Index map No. 13).—Two sheets, Kāthiāwār and Andamans, were published during the year and three are in hand.

70. *(f)* **General Maps on small scales.**—The Political edition of the Map of India and Adjacent Countries, scale 32 miles to 1 inch, in 12 sheets, was published and a commencement has been made with the hill shading for a shaded and layered edition.

The annual edition of the Railway Administration Map of India was published as usual. Two Provincial maps, Bihār and Orissa, and the Punjab, have made good progress.

71. *(g)* **Special maps.**—Many special maps, &c., have been prepared for the various departments of Government, both Imperial and Local, and for the General Staff.

72. The most noticeable features this year in the Map Publication Offices are:—

(*a*) The large increase of pulls in the Photo.-Litho. Office, 33% over the previous record.

(*b*) The steady and constant increase of maps issued by the Map Record and Issue Office.

(*c*) The great increase in maps which are folded with stiffeners, with titles on the front and often indexes at the back, entailing a large increase of work.

73. Map Record and Issue Office.—The face value of maps received during the year under report, from the printing offices amounted to Rs. 4,89,206. This sum includes Rs. 5,344 and Rs. 59,494, the value of maps printed in the Engraving and Dehra Dūn Offices respectively.

Details of the numbers and classes of maps published during the year and their face value are given in Table IV on page 32.

The total number of maps issued from the Office during the year was 437,131 of an aggregate value of Rs. 2,17,853.

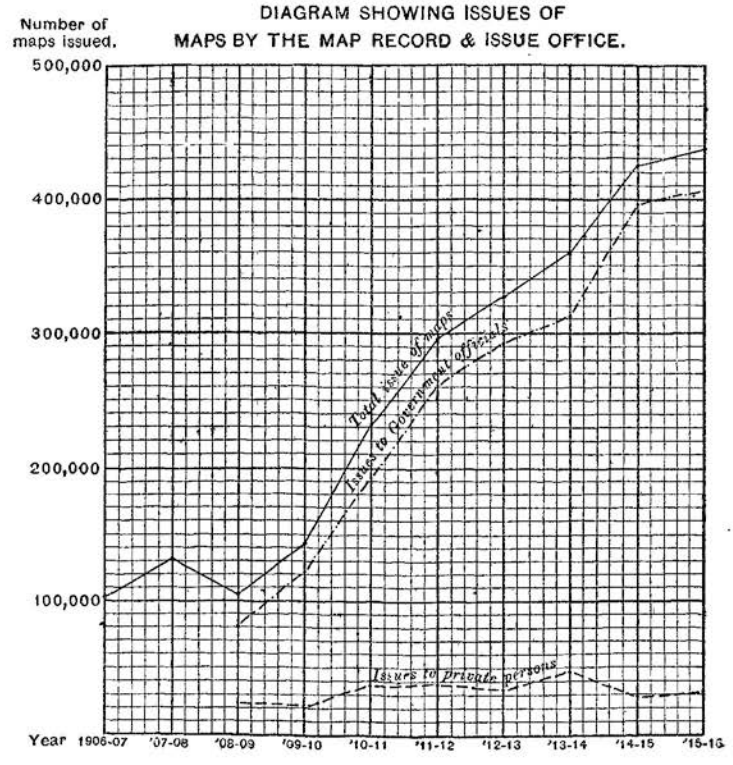
The details are as follows:—

	Government Officials.	*India Office.*	*Departmental Issues.*	*Private Individuals.*	*Map Agents.*	**Totals for 1915-16.**	*Totals for 1914-15.*
No. of maps	304,129	5,229	96,634	28,181	2,958	**437,131**	425,008
Value Rs.	1,10,660	6,835	74,554	23,077	2,727	**2,17,853**	1,78,958

The number of maps, covered by 1827 separate orders, supplied to the military authorities was 140,084 of an aggregate value of Rs. 79,652.

It may be noted, as showing the increased use to which the maps of India are being put, that in the Survey year 1906-07 the numbers issued by this office were 103,502 as compared with 437,131 issued last year, so that during the preceding ten years the numbers have increased more than four-fold. This increase is chiefly due to the larger number issued to Government officials which

last year totalled 405,992, while private persons, who in 1908-09 took 23,940 maps, only ordered 31,139 last year. From this it would appear that our maps do not receive the same appreciation from private individuals as from Government officials. The diagram below illustrates the figures for the last ten years :—



The building of the new racks for maps in one of the map store rooms, which was commenced during the year by the Mathematical Instrument Office, is practically complete and the racks will shortly be ready to accommodate a stock of 1,386 modern size sheets.

74. No. 1 (Head Quarters) Drawing Office.—Two sheets of the India and Adjacent Countries Series on the one-millionth scale were drawn and will be sent for publication shortly. Towns and village sites are now classified according to their administrative importance, and the style and size of the lettering of their names varies with their administrative importance and population. Four sheets which were published previous to this classification have been altered accordingly: one has been sent for reprint, and the remaining three should be completed by the middle of November 1916. Four other sheets of this series are in various stages of completion. The compilation and drawing of three sheets of the Southern Asia Series, two-millionth scale, are well advanced: one sheet should be ready for publication by the middle of next year.

The patterns of three sheets were prepared for the engraved edition of the one-millionth India and Adjacent Countries Series, and two are in hand. Two patterns of the one-millionth International Series, in which the values of heights and contours are in metres, were supplied to the Engraving Office, and the patterns of four other sheets are well advanced. The compilation of a large area for the four-millionth map of India, which is to supersede the present 64-mile map, has now been supplied to the Engraving Office.

The Mapping and Reprint Sections completed 20 degree sheets based on old atlas sheets, and 17 are in hand. These degree sheets are classed as "Provisional Issues" and printed in black. They have been brought up to date as regards railways, roads, canals, &c., from information supplied from extra-departmental sources. They will be eventually superseded by modern degree sheets in colours when the area comprising them comes under revision survey. The Provincial maps of the Punjab and Bihar and Orissa on the one-millionth scale were in hand the latter having been sent for publication, and that of Assam was brought up to date from the latest information available. These Provincial maps are in the same style as, and based on, the one-millionth sheets covering the same area. A Population Map of India, scale 180 miles to an inch, with surprint original to illustrate the co-operative credit statistics for 1914-15 was completed and published. The 32-mile Railway Station Map of India, which was last revised in 1912, has been corrected up to 31st March 1916. Patterns were supplied to the Engraving Office of the 32-mile map of India for the purpose of correcting the copper plates for the new edition of the political and layered editions of this map. The former was published during the year. The 64-mile map of India showing railways open and under construction was corrected up to March 1916. The originals of 127 maps on various scales have been brought up to date to supply reprints. In addition, a large number of maps drawn in circle offices and field parties have passed through the Drawing Office for minor corrections. A considerable number of special military orders were executed in this section.

Thirty-four sheets on various scales were stump-shaded and sent for printing, and 10 are in course of preparation.

Six maps of *the new half-inch series* were completed during the year. Four sheets in various stages of completion are expected to be ready for publication by March 1917.

The *Office Copy Section* continued to maintain a complete record of all alterations and additions since the date of survey that are brought to notice by the local authorities so that this information may be included in new editions of maps. Such additions and corrections have been carried out on 2,526 maps. Office copies of 746 new maps have been made during the year to record similar changes. In addition to this work the section had to deal with various questions regarding Revenue Survey maps. It also supplies copies of original records to Government officials and private individuals who may require them.

The *Examining Section* has dealt with 384 cases during the year in addition to a great deal of miscellaneous work.

75. Engraving Office.—In the course of the year under report three maps of the one-millionth India and Adjacent Countries Series and two International maps on the same scale were completed, and transfers from the engraved plates were supplied to the Photo.-Litho. Office. Six International and five one-millionth maps and one Degree sheet are in hand. Of these one International, three one-millionth and the Degree sheet are almost complete.

The engraving of the new map of India on a scale of one over four-million, which was referred to in last year's report, has made good progress. This map is in four sheets and as each of the sheets requires three copper plates for the black, blue and brown colours there are 12 plates involved.

During the year the periodic correction of the plates of the small scale maps of India and of Districts has been carried on. In this connection it was found necessary to engrave 3 new District plates owing to the redistribution of areas rendering the old maps obsolete. Also 2 new Index charts for the catalogue have been engraved.

All the plates of the 32-mile map of India used for the political and layered editions of this map have been revised and transfers supplied for reproduction.

The following maps were revised on the copper plates:—The Provincial map of Madras, scale one inch to 16 miles, Calcutta, scale 6 inches to 1 mile, 50 District maps, 34 Indexes and 24 Atlas of India sheets. The revision of the latter was necessary before the sheets could be reprinted to replenish stock.

Among the miscellaneous work carried out may be mentioned the engraving of the table of Conventional Signs. The object in view being to improve, as much as possible, the patterns which draftsmen should follow in the drawing of original maps; it is considered this can be best achieved by engraving. A good deal of work was done in connection with the engraving of titles on photogravure plates which had been prepared in the Photo.-Litho. Office.

In the *Printing Section* of this office 23,656 impressions were made as against 30,872 last year. This decrease is due almost entirely to the fact that the Atlas sheets of India, which were formerly printed in this office are rapidly being replaced by the modern Degree Sheet Series, and the Provisional Issue Degree Sheets already referred to in the report of No. 1 Drawing Office. Of the impressions taken 8,215 were for extra-departmental orders, 1,165 Commission forms and 7,050 photogravures. A considerable numbers of engraved scales for various purposes were also printed.

In the *Steel Facing Section* 286 plates were treated.

76. Photo.-Litho. Office.—During 1915-16 there was a steady demand for maps for the use of Expeditionary Forces. This demand together with a large quantity of work required by departments other than the Survey of India resulted in a high outturn for the year.

The number of impressions pulled in the machine presses was 2,479,129 giving 735,999 finished maps and diagrams. From these figures it is seen that an average of between three and four printings has been required to produce each finished copy.

The corresponding figures for 1914-15 were 1,987,591 impressions and 730,917 copies. It will be noticed that, though the number of copies turned out in 1915-16 showed no large increase over the figure for the preceding year, yet the work that had to be done to produce that number of copies was much greater, the maps of 1914-15 having averaged between only two and three printings per sheet, a large proportion of the maps having been uncoloured. The highest monthly outturn was attained in January 1916, when 101,468 completed copies were produced.

Nine machine presses ran for the whole year and for a few months ten machines were working. The total machine power for the 12 months was 112 machine months as against 94 machine months for the previous year. There has thus been an increase of 19% in the utilised machine power. The tenth a Quad Crown by Mann & Co. was brought into use in March 1916.

During the year the office supplied one Double Elephant size hand press to the Expeditionary Forces. The remaining fifteen hand presses produced 19,656 proof impressions.

About 28% of the total outturn represented maps printed for the department while the remaining 72% was composed of work done for the Army and other departments.

The work done for the department includes 218 new and 23 reprint editions of modern style *one-inch maps* in colours. Preliminary editions of 31 sheets were printed in black or black and brown. This includes four sheets reprinted. Besides these 36 one-inch maps were reprinted in the old style. The total number of one-inch maps published during the year was thus 308. *Village Boundary editions* were printed of 19 modern one-inch sheets. Of the *new half-inch series*, 29 sheets were published in colours. No reprints have so far been issued of any sheets of this series. During the year 62 new quarter-inch *Degree sheets* were printed, 22 being Provisional editions. In addition 133 Degree sheets were reprinted either in colours or in black or black and brown. Reprint editions of 17 *Atlas of India sheets* were also published.

The *Negative and Retouching Sections of the Photo. Branch* have dealt with 3,784 and 4,112 negatives respectively, while the *Helio and Vandyke Sections* together turned out 5,333 plates.

In the matter of methods and processes, no great changes have been introduced but several modifications of existing methods have been effected. Mr. Vandyke has devoted himself to investigating the possibility of improving the printing and lasting qualities of the helio and to developing the methods of preparing tint and layer plates. The results of his work have been most successful and distinct improvements in the quality of the plates and the printed impressions have been attained.

The *Photo. Engraving Section* during the year prepared 20 photo-gravure plates, 531 half-tone blocks and 141 line blocks. From the half-tone and line blocks an aggregate of 980,593 impressions were pulled.

The *Type Printing Section* set up 5,383 pages of matter of which, in all, 1,143,075 copies were printed, 2,053,663 impressions being pulled.

Out-turn of Photo.-Litho. Office during 1915-16.

TABLE A.

1	2	3	4	5	6	7
Year.	Cost of office.	Value of out-turn at cost-rates.	Recovered in cash or by book-debit.	Number of maps printed.		
				Depart-mental.	Other than Departmental.	Total.
	Rs.	*Rs.*	*Rs.*			
1913-14	1,67,801	2,40,721	33,468	491	1,975	2,466
1914-15	1,56,515	2,31,146	36,847	597	2,168	2,765
1915-16	**1,80,603**	**3,41,782**	**63,791**	**847**	**2,229**	**3,076**

TABLE B.

1	2	3	4	5	6	7
Year.	Number of impressions pulled in Litho. Branch.	Number of half-tone impressions pulled.	Number of line-block impressions pulled.	TYPE SECTION OUT-TURN. Pages or items published.	Copies printed.	Impressions pulled.
1913-14	2,286,845	35,710	875,000	6,403	1,203,242	2,132,159
1914-15	2,100,103	65,732	1,491,403	5,987	1,317,298	2,122,811
1915-16	**2,975,149**	**86,373**	**894,220**	**5,383**	**1,143,075**	**2,053,663**

77. Mathematical Instrument Office.—During the year from 1st April 1915 to 31st March 1916, there was a reduction in the demands made on this office (*vide* item 1 in para. 2) as well as in the value of work done (*vide* item 6 in para. 2), and there was respectively a loss of Rs. 6,145 and Rs. 30,421 against a profit of Rs. 38,366 and Rs. 22,012 in the year 1914-15. The losses are however merely nominal, and are due to invoices for certain items of heavy work done in the Workshop and issued from the Serviceable Stores not having been drawn in 1915-16 but during the current official year, and hence the figures did not appear in the accounts for 1915-16.

2. Below are given the usual comparative figures for the last 3 years :—

	1913-14.	1914-15.	**1915-16.**
	Rs.	*Rs.*	**Rs.**
1. Total issues to Public Offices as shown in the Profit and Loss statements of stores.	4,07,802	4,16,642	**2,51,818**
2. Value of repairs to instruments received for repairs and returned in a serviceable condition.	56,418	66,793	**52,535**
3. Value of instruments received from Government Officers when no longer required.	69,806	50,924	**54,411**
4. Book value of the stock of instruments, &c., in Serviceable Stores.	4,73,470	5,06,865	**5,68,631**
5. Book value of the stock of instruments, &c., in Repairable Stores.	67,299	62,347	**70,896**
6. Total value of work done in the Workshop ...	2,40,752	2,44,054	**1,96,704**
7. Value of instruments manufactured in the Workshop for Serviceable Stores.	93,991	87,421	**71,641**
8. Value of instruments purchased locally ...	9,060	9,792	**11,255**
9. Value of instruments and materials obtained from England through the Director General of Stores.	89,213	2,78,380	**1,69,073**
10. Average No. of employees and their pay ...	No. 300 } Rs. 76,734 }	No. 317 } Rs. 80,917 }	**No. 337 } Rs. 91,654 }**

3. During the year the stock of all the three stores, (the Serviceable, the Repairable and the Material Stores), was twice taken and the discrepancies noticed have been adjusted.

Table IV.—Departmental Publications, Calcutta, 1915-16.

Note.—For special publications at Dehra Dūn, *vide*, pages 33 to 37.

Class of Maps.	Scale.	Number of different maps of each class received.		Number of copies printed.	Value.
		New Publications.	New Editions and Reprints.		
GEOGRAPHICAL MAPS.					*Rs.*
Maps of India	Various	3	4	1,820	8,530
Southern Asia Series	1:2,000,000	2	5	2,360	5,145
India and Adjacent Countries ...	1:1,000,000	5	4	7,805	7,805
Do. (International Series) ...	1:1,000,000	1	.....	300	300
TOPOGRAPHICAL MAPS.					
DEGREE SHEET SERIES.					
Modern	1″-4 miles	5	10	14,818	14,421
From Atlas material	Do.	28	23	15,169	15,019
HALF-INCH SERIES.					
Modern	1′-2 miles	25	.....	12,280	12,280
ONE-INCH SERIES.					
Modern	1″-1 mile	195	28	105,282	1,02,682
Do. (Preliminary Editions) ...	Do.	26	.....	13,000	12,250
Do. (Village Boundary Editions)	Do.	.....	19	1,900	3,800
Old Style Sheets	1″-1 mile & 1″-4 miles	.....	44	12,185	18,572
MISCELLANEOUS.					
Atlas of India Series	1″-4 miles	.....	72	8,585	8,967
Provincial Maps	Various	1	10	2,770	4,526
District Maps	1″-4 miles	.....	20	5,289	5,439
Administration Report Maps ...	1″-8 miles to 1″-16 miles	4	23	1,230	400
Plans of Cities and Cantonments ...	Various	9	3	924	5,756
Index Maps ...	Do.	20	26	25,038	5,584
Miscellaneous Maps	Do.	1,022	203	395,274	2,57,730
Totals for 1915-16	.....	**1,356**	**494**	**626,329**	**4,89,206**
Corresponding totals for 1914-15 ...	.....	500	785	615,519	3,82,246

LETTERPRESS.

1. Survey of India. General Report, 1914-15. *Price Rs. 2.*
2. Records of the Survey of India, Volume VII, 1913-14. *Price Rs. 4.*
3. Do. do. do. IX, 1914-15. *Price Rs. 4.*

II.—DEHRA DŪN OFFICES.

TRIGONOMETRICAL SURVEY OFFICE.

78. Computing Office.—The revisionary triangulation at the junction of the Burma Coast Series and the Manipur Meridional Series was completed in February 1916 by No. 15 Party and the adjustment of the Burma Quadrilateral, which was stopped pending the completion of the above, was resumed according to the new and short method referred to in the previous report. It is hoped that the adjustment will be finished in 1916, when it will be possible to proceed with the publication of the Burma triangulation pamphlets. The adjustment by the above method of the Ashta (No. 88), Naldrug (No. 90), Middle Godāvari (No. 92), Rānchi (No. 83) and Sambalpur Meridional (No. 85) Series was effected.

The values of M, a criterion of the accuracy of triangulation, were revised, and the probable circuit errors of the five Indian Quadrilaterals computed and found to be in accordance with the actual errors.

Further computations in connection with Professional Paper No. 16, now in the press, were made during the year.

Computations of Dynamic and Orthometric heights of the following twelve lines of levelling were accomplished during the year:— Dacca to Mymensingh; Tindhāria to Darjeeling; Raichūr to Bāgalkot; Bareilly to Hāthras; Bareilly to Meerut; Ambāla to Meerut; Sargodha to Multān and Mahiwala; Solon to Simla; Ferozepore to Multān (Revised); Multān to Bahāwalpur; Jacobābād to Quetta; and Bellary to Gooty (Revised).

Elephant Point had hitherto been the levelling datum of the whole Burma Levelling, but a reconsideration of the results with two of the tidal observatories in Burma led to the adoption of Amherst as the level datum for Burma Levelling. This necessitated the recomputation and revision of all the Burma heights previously published, which were only provisional so far as the orthometric values were concerned. The orthometric reduction of the provisional values is now being effected, so that the resulting heights will not be modified for many years to come, probably not until a junction with the Indian Levelling is effected.

Graticule Tables, on the Modified Secant Conical and Polyconical Projection Systems, for Part I of the Auxiliary Tables, 5th Edition, (which is now in course of publication by parts) were computed and arranged.

A card index of the records has been begun and is nearly complete and all the records are now satisfactorily stored in suitable racks.

Data were supplied to ten departmental and non-departmental officers from the old manuscript records and in some cases such requisitions were met by a supply of printed data. A large number of requisitions for professional forms was attended to.

About 225 degree triangulation pamphlets in all were compiled and compared, 180 of them passed through press and 132 were distributed.

Addenda to Levelling Pamphlets Nos. 43, 47, 78 and 79; Five figure Tables of Log. Sines and Cosines; Auxiliary Tables, Part I (Graticule Tables), 5th Edition; Departmental Paper No. 7 and Record Volume VI were bound and distributed. Professional Paper No. 15, and Record Volume VIII in two parts, are in the hands of the binders and will shortly be out. A new stitching machine has greatly facilitated the work of the binding establishment.

The geodetic and astronomical observations of Rai Bahadur Lal Singh, Muhammad Yakub Khan and Muhammad Afraz Gul, who accompanied Sir A. Stein to Central Asia, were reduced.

79. Type Printing Office.—The following publications have been printed during the year :—

(1) Triangulation Pamphlets ... ... 180.
(2) Addendum to Levelling Pamphlet No. 39
" " " 47
" " " 78
" " " 79
Levelling Pamphlet No. 34.
(3) Auxiliary Tables, Part I, 5th Edition.
(4) Professional Paper No. 16 pages 69—104.

80. Workshop.—A sensitive drilling machine has been received during the year. The integrator reported as under construction last year has been satisfactorily finished.

81. Observatories.—Meteorological observations were continued as usual.

The Omori Seismograph has been working throughout the year. The local earthquake of 29th August 1916 dislocated it, so that no proper record was obtained. Other earthquakes were recorded.

Photographs of the sun have been taken on 339 days during the year, the sun being obscured on the remaining days.

82. Preservation of Trigonometrical Stations.—894 stations were repaired by the district officers at a cost of Rs. 4,653-2-1.

Out of 352 districts from which reports are annually due, 24 failed to make returns.

83. No. 2 (Dehra) Drawing Office.—During the year the work in this office was carried out by the following sections :—

(*a*) Cantonment;
(*b*) Triangulation;
(*c*) Compilation and Half-inch;
(*d*) Miscellaneous.

A special section was also formed to deal with the mapping of the recent explorations by Sir A. Stein and Cavaliere de Filippi. This section was made up of draftsmen taken from the Half-inch and Cantonment sections, which were considerably reduced. A small section of draftsmen drawn from the Compilation section, was created to deal with the revision of the map of Arabia on the scale of 1 inch = 32 miles. This section was eventually taken over by Colonel Wauhope.

The following is a summary of the work of the office during the year 1915-16 :—

Class of map.	Sheets sent to press.	Remaining in hand.	REMARKS.
Rough compilation of map of Tibet for publication on the scale of $\frac{1}{4,000,000}$ ...	3	1	Hill and skeleton.
Geographical maps, $\frac{1}{1,000,000}$ scale. (Fair sheets)	4	7	
Geographical maps, $\frac{1}{1,000,000}$ scale. (Rough compilation)		11	2 sheets for Southern Asia Series, scale $\frac{1}{2,000,000}$.
Miscellaneous Scientific diagrams and charts	6		
Preliminary degree triangulation charts ...	130	18	92 published.
Final degree triangulation charts ...	4	2	
Half-inch Series	9	9	Includes 4 sheets of Aden Survey.
Cantonment maps	* 74 Cantonments 196 Sheets.	47 Cantonments 108 Sheets.	* Completed and stored.
Explorers' route maps	12		
Index chart to the Great Trigonometrical Survey of India, $\frac{1}{3 \text{ million}}$ scale ...	4		
Levelling charts	3		
Regions between Leh and Karghalik mapped by Cavaliere de Filippi's expedition in 1913—15, for publication on the $\frac{1}{500,000}$ scale	2	*Nil*	Will be published in one sheet.
Sir Aurel Stein's exploration in Chinese Turkistān and Kansu in 1900-01, 1906—08, 1913—15, drawn on the scale of 6 miles to an inch for publication on the $\frac{1}{500,000}$ scale.		49	The compilation of these 49 sheets on the $\frac{1}{500,000}$ scale is completed and the fair mapping of ten sheets in hand.
Miscellaneous Extra-departmental maps ...		34	
Map of Arabia and Persian Gulf, scale 1 inch = 32 miles	4		

NOTE.—The following Index charts are in hand and copies will be available in January 1917.

(1) Index to the Triangulation Degree Charts of India, scale 1 inch = 128 miles.

(2) Index Chart to the Great Trigonometrical Survey of India, scale 1 inch = 96 miles.

(3) India showing stations of observation of the Magnetic Survey, scale 1 inch = 96 miles.

(*a*) *Cantonment Section.*—The work in this section will in future be of rather a light nature as all the fair sheets have been brought up to date and there will only be the usual annual corrections to deal with.

(*b*) *Triangulation Section.*—The work of this section was greatly facilitated and expedited by Circular Order No. 185 (Professional) of the 22nd April 1915, which allowed of preliminary charts being prepared without reference to the Topographical Circles concerned.

(*c*) *Compilation Section.*—The compilation of the area allotted to No. 2 Drawing Office, *viz*:—Latitude 28° to 48° and Longitude 72° to 104°, has practically been completed on the 1 inch = 12 miles scale and will form the basis for the Himālayan map, and the maps of the $\frac{1}{1,000,000}$ and $\frac{1}{2,000,000}$ series.

(*d*) *Half-inch Section.*—In this section the work was hindered by the transfer of the section officer and by the removal of several draftsmen to form a section for the mapping of Sir A. Stein's explorations.

(*e*) The map of the de Filippi exploration, between Leh and Karghalik will be published in one sheet on the $\frac{1}{500,000}$ scale.

The new maps that are being drawn for Sir A. Stein will comprise his explorations during 1900-01, 1906—08 and 1913—15 and will be published in 49 sheets on the $\frac{1}{500,000}$ scale.

84. Photo.-Zinco. Section.—During the year 1915-16 the work undertaken comprised :—

Forest maps;
Cantonment maps;
Triangulation charts;
Levelling charts;
Extra-departmental maps.

During the year under review a great number of degree sheets drawn in No. 6 Drawing Office have been reprinted for the Chief of the General Staff, Simla.

The following statement shows the work done in the Photo.-Zinco. Section for the past three years :—

Year.	No. of Subjects.	No. of Negatives.	No. of Pulls.	Chocolate and Cyanotype prints.
1913-14 ...	2,046	2,376	244,140	1,695
1914-15 ...	1,898	2,267	345,520	663
1915-16 ...	**2,065**	**1,717**	**307,357**	**1,209**

One Graining and one Litho. machine have been received and are under erection.

The method of storing Register slips and proofs in the past was considered unsatisfactory and is now under revision.

85. Forest Map Office.—The total number of maps issued during the year, both to officials and the public, amounted to 9,107, a decrease of 8,848 on last year's total. The gross face value of these maps was Rs. 15,649, and the net amount realised from sales was Rs. 4,492, against Rs. 6,864 in the previous year. Of this amount, Rs. 3,252 was recovered by book-debit and Rs. 1,240 by cash from sales to private individuals and trading companies. The number of maps and field sections received for

storage during the year was 13,071, besides 24 computation volumes, traverse field books, and angle books, and 37 traverse charts and plot sheets.

The following table shows, in abstract form, the work dealt with by the office :—

Class of maps.	Number of sheets.		
	In hand.	Drawn and sent for publication.	Published.
1-inch, 2-inch and 4-inch maps of Forest Surveys	225	107	65
Special maps of India ...	...	...	2
Provincial, Divisional and District Forest maps ...	38	16	6
Working Plans and Miscellaneous maps ...	8	31	28
Totals ...	271	154	101

III.—CIRCLE AND LOCAL DRAWING OFFICES.

86. No. 3 Drawing Office (Northern Circle).—During the year 42 one-inch sheets previously surveyed and drawn by parties, and one other one-inch sheet brought up to date in the Drawing Office for reprinting, and not included in the above number, were submitted for publication.

The proofs and colour patterns of 64 sheets, including those of half-inch and quarter-inch sheets were prepared and returned to the Superintendent, Map Publication leaving a balance of colour patterns of 8 sheets still in hand.

Half-inch sheets compiled from modern one-inch and old style half-inch maps.—During the year 12 sheets were fair-drawn in the Drawing Office and parties of the Circle and submitted for publication.

On the basis of the one-inch sheets published up to 30th September 1916, there now remain for completion in the Northern Circle 139 half-inch sheets of the kind under consideration. Of this number, the fair-drawing of 34 sheets is in hand, and the material for the preparation of 20 more has been received.

The above numbers do not include 2 half-inch sheets in hand which are being drawn from original surveys on the half-inch scale; but do include the numbers dealt with under Part 2, Section I, page 12.

Quarter-inch sheets compiled from one-inch and half-inch maps.—During the year the fair-drawing of one sheet was completed and the sheet submitted for publication, leaving the fair-drawing of 5 sheets in hand and that of 3 sheets of which the component one-inch or half-inch sheets have been published, yet to be put in hand.

The layer guide of 38 O was prepared and submitted for the layered edition of this sheet.

Miscellaneous.—During the year the traverse plots of stations of 13 *mauzas* consisting of 24 sheets, scales 16 and 32 inches to a mile, of Gondá district, were prepared for, and sent to, the Deputy Commissioner, Gondá. The cost has been recovered.

87. No. 4 Drawing Office (Southern Circle).—During the year 56 one-inch and 5 half-inch sheets, which had been surveyed and fair-drawn by parties, were finally examined and submitted for publication. At the end of the year every sheet, the survey of which was completed during previous years, had been submitted.

Half-inch sheets compiled from one-inch maps.—8 sheets were fair-drawn and submitted for publication and 6 sheets, which had been fair-drawn by parties, were finally examined and submitted for publication. At the end of the year 9 sheets were being fair-drawn in this office, 20 sheets were being fair-drawn by parties and 28 sheets, the component one-inch sheets of which had been published, had not been commenced.

Quarter-inch sheets compiled from one-inch and half-inch maps.—No sheet was submitted for publication. At the end of the year 4 sheets, the component one-inch sheets of which had been published, were being fair-drawn and every sheet, the component half-inch sheets of which had been published, had been commenced.

The examination and colouring of the proofs of 76 sheets and the hill shading for 66 sheets were completed and returned to the Superintendent, Map Publication.

A number of pupils were instructed in fair drawing.

Considerable assistance was given to parties to enable them to complete their fair-drawing during the recess season.

The Photo.-Zinco. Section undertook the photographic and zincographic work required in the circle.

88. No. 5 Drawing Office (Eastern Circle).—During the year, of 21 one-inch sheets which were received from the parties, 17 were submitted for publication; 16 unpublished proofs were received and 14 of these were examined, coloured, stump shaded originals prepared, and submitted for publication. 5 proofs of the previous year were similarly prepared and submitted.

Sixteen one-inch reprint cases were dealt with and 14 of these were submitted for publication, of these 11 unpublished proofs were received and 3 were completed and returned. The colour guides of two other were also prepared. The stump shaded originals of 8 are yet to be prepared.

Half-inch sheets compiled from one-inch maps.—17 were received from the parties, 14 were examined and sent for publication, 9 uncorrected proofs of these were received back for examination, preparation of colour guides and stump shaded originals and of these 2 were re-submitted.

Besides the foregoing 6 proofs of the previous year were prepared and submitted.

Quarter-inch sheets compiled from one-inch and half-inch maps.—One sheet was received in the drawing office. 6 were submitted for publication, 5 proofs were received and 2 were completed and re-submitted. The degree sheet (94 G) referred to last year as being incomplete, will shortly be submitted for publication, the references regarding its boundaries and forest limits have now been decided by the local authorities.

Of the one-inch sheets the survey of which was completed during the previous year all have been submitted for publication with the exception of 4 unavoidably detained for settlement of boundary questions, which have now been decided and the sheets will shortly be submitted.

89. No. 6 (Simla) Drawing Office.—As during the previous year this office was organized in 2 sections.

The *Army Section* has dealt with the preparation and reproduction of maps and plans for the use of the Army in India while the *Survey Section* has been employed on the preparation of trans-frontier maps on the one-millionth, quarter-inch and half-inch scales.

Most of the work of the *Survey Section* has consisted in redrawing in modern style, and sometimes to a reduced scale, the maps already existing, with the incorporation of such additional information of recent date as may have been available.

90. Bengal and Bihar and Orissa Drawing Office.—(*Imperial Standard Mapping Section*). This office continued under the direction of the Director of Surveys, Bengal.

In Bihār and Orissa, 13 one-inch sheets were submitted for publication, 4 are nearly ready and 27 are in hand, only 8 sheets of this Province remaining to be taken up.

In Bengal 13 one-inch sheets were submitted for publication, 2 are nearly ready and 25 are in hand. Two changes regarding the maps prepared in this office have been introduced:—(*a*) in previous years all areas containing hills or waste land which were not surveyed were shown blank, in future these blanks will be filled up from old one-inch maps; this will reduce the outturn but the maps produced will be much more useful for general purposes; (*b*) these sheets being much nearer in quality to topographical maps than previously will therefore be published in colours.

PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS.

91. Northern Circle.—*No. 2 Party* carried out a survey on the four-inch scale of the head works of the Lower Bāri Doāb Canal for the Irrigation branch of the Punjab Public Works Department.

One surveyor was deputed for this work which was under execution from the 28th January 1916 to the end of the Survey year.

No. 20 Party (Cantonment).—This Party continued the survey of the Cantonments and Military stations of Upper India. The details of the work done by it are shewn on page 17.

Punjab Riverain Detachment.—As in previous years this Detachment was exclusively employed on local surveys in the Punjab. The details of the work done are shewn on pages 18 and 19.

Simla Survey Detachment completed the new large scale survey of the Simla Municipality, for details see page 19.

92. Southern Circle.—The special survey on the scale of 1½ inches to a mile of reserved forests in the Hyderābād State was commenced. No. 6 Party surveyed an area of 30 square miles and triangulated an area of about 200 square miles. The cost of this work is being borne by the Nizām's Government.

One surveyor of No. 7 Party was placed on deputation during the field season with the Madras Survey Department to survey disputed boundaries in the Parlākimedi Māliahs of the Ganjām district of Madras.

One surveyor of No. 8 Party was placed on deputation during the field season with the Forest Department in Coorg to survey several forest plantations in the neighbourhood of Mercāra.

93. Eastern Circle.—At the request of the General Staff, Burma Division, No. 11 Party surveyed an area of 70 square miles about 25 miles due north of Maymyo, on 1-inch scale, for the preparation of the Artillery Practice Camp Map.

94. Map Publication Offices.—A large proportion of the work of the Photo.-Litho. Office is for other Government departments; weather charts, photographs for the Archæological and other departments, plans, maps for the General Staff and many others were reproduced during the year, the increase of machines enabling the Survey of India to take up most of the work sent in. The Drawing Office also prepared Postal, Railway, Manœuvre, Artillery Practice and other maps, while the Map Record and Issue Office's main work is the issue of maps to other departments.

95. Mathematical Instrument Office.—Heliographs, watches, range finders, and periscopes, &c., have been issued and repaired in large quantities, and this office as usual supplied and repaired instruments for all Government offices, Provincial and Imperial.

96. Dehra Dun Offices.—A very accurate traverse of the boundary of the Imperial Delhi Area on the right bank of the Jumna was executed by No. 19 Party at the request of the Chief Engineer, Public Works Department, Delhi Province.

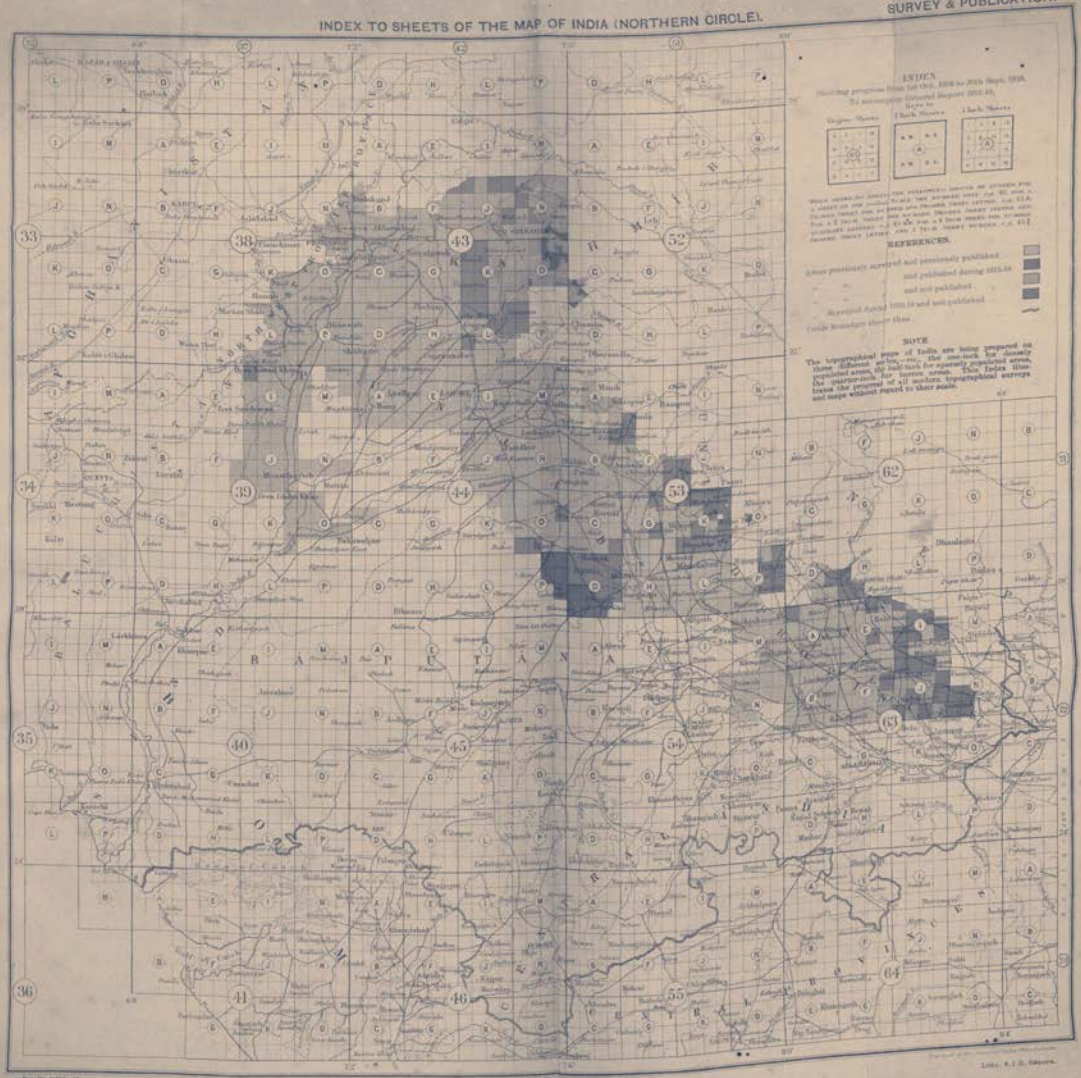
A considerable number of requisitions for data, particularly with regard to the most recent lines of levels, which have not yet been published, were complied with by the Computing Office.

Five maps of various kinds were produced by No. 2 Drawing Office for other departments.

LIST OF INDEX MAPS.

1. Modern surveys and publication, Northern Circle.
2. ,, ,, ,, ,, Southern ,,
3. ,, ,, ,, ,, Eastern ,,
4. Publication of modern one-inch series, Northern Circle.
5. ,, ,, ,, ,, ,, Southern ,,
6. ,, ,, ,, ,, ,, Eastern ,,
7. ,, provisional editions of one-inch series, Northern Circle.
8. ,, ,, ,, ,, ,, Eastern ,,
9. ,, modern half-inch series for India.
10. ,, ,, quarter-inch ,, ,,
11. ,, 'India and Adjacent Countries' series, scale $\frac{1}{1,000,000}$.
12. ,, Indian sheets of "La Carte Internationale du Monde," scale $\frac{1}{1,000,000}$.
13. ,, 'Southern Asia' series, scale $\frac{1}{2,000,000}$.
14. Progress of the Great Trigonometrical Survey.

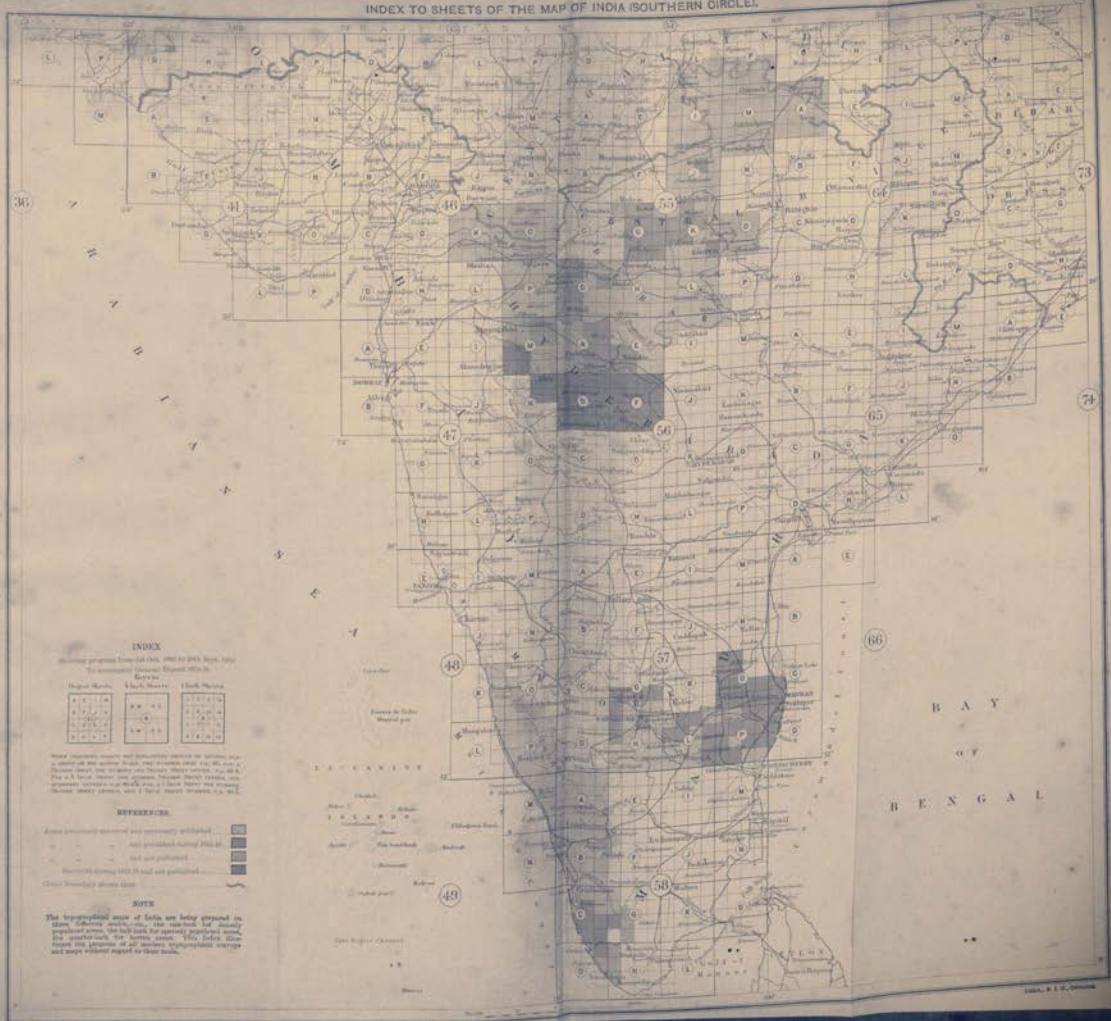
INDEX TO SHEETS OF THE MAP OF INDIA (NORTHERN CIRCLE).



MODERN SURVEY & PUBLICATION

(Northern Circle).

INDEX TO SHEETS OF THE MAP OF INDIA (SOUTHERN CIRCLE).



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(Southern Circle).

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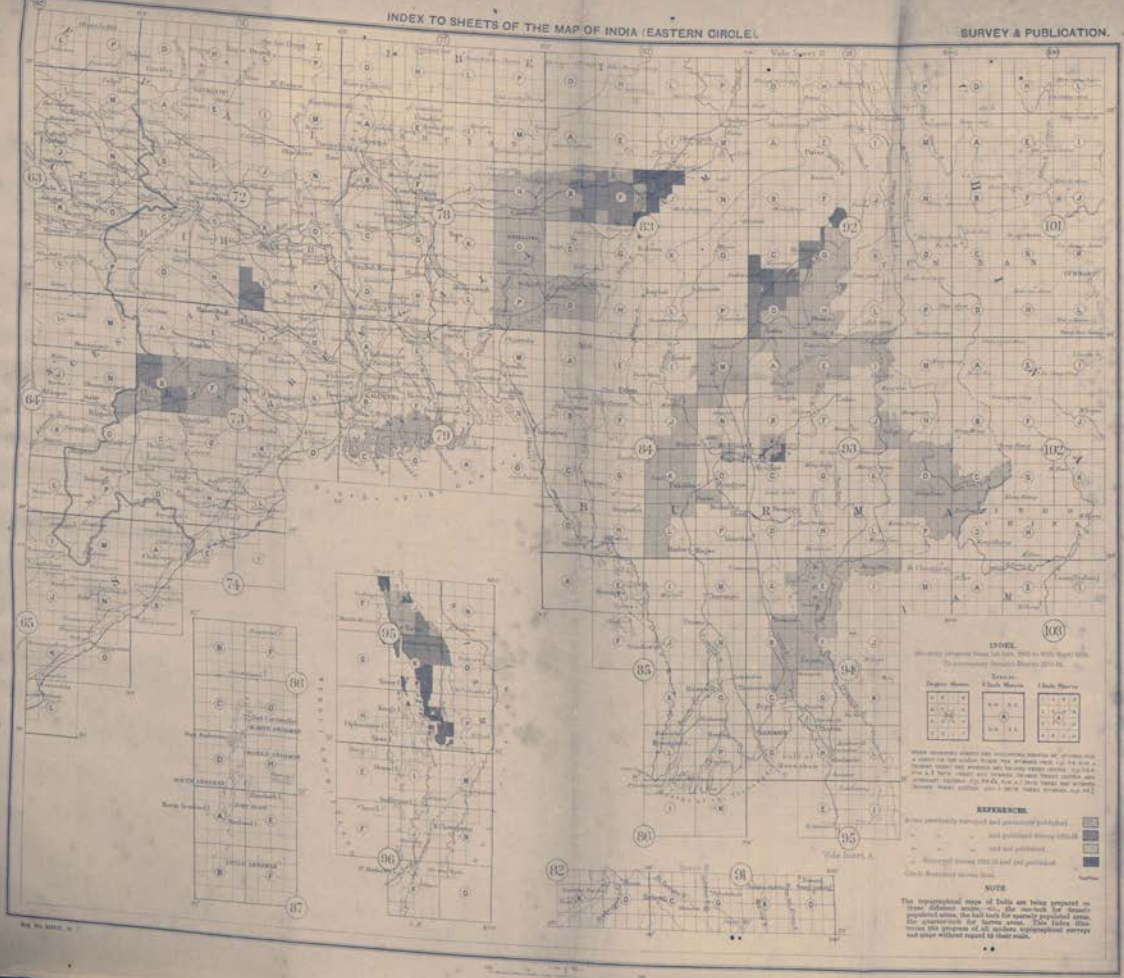
SURVEY & PUBLICATION.



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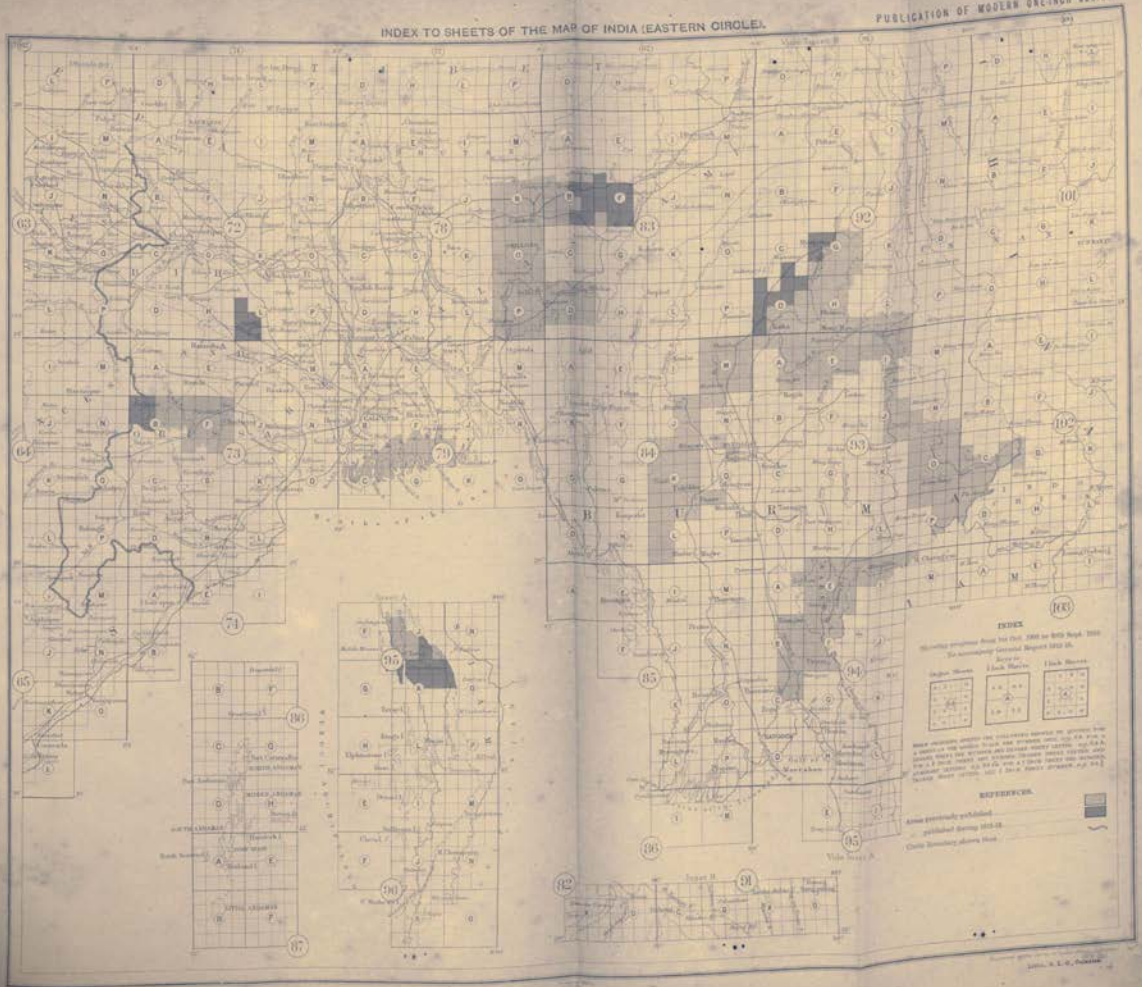
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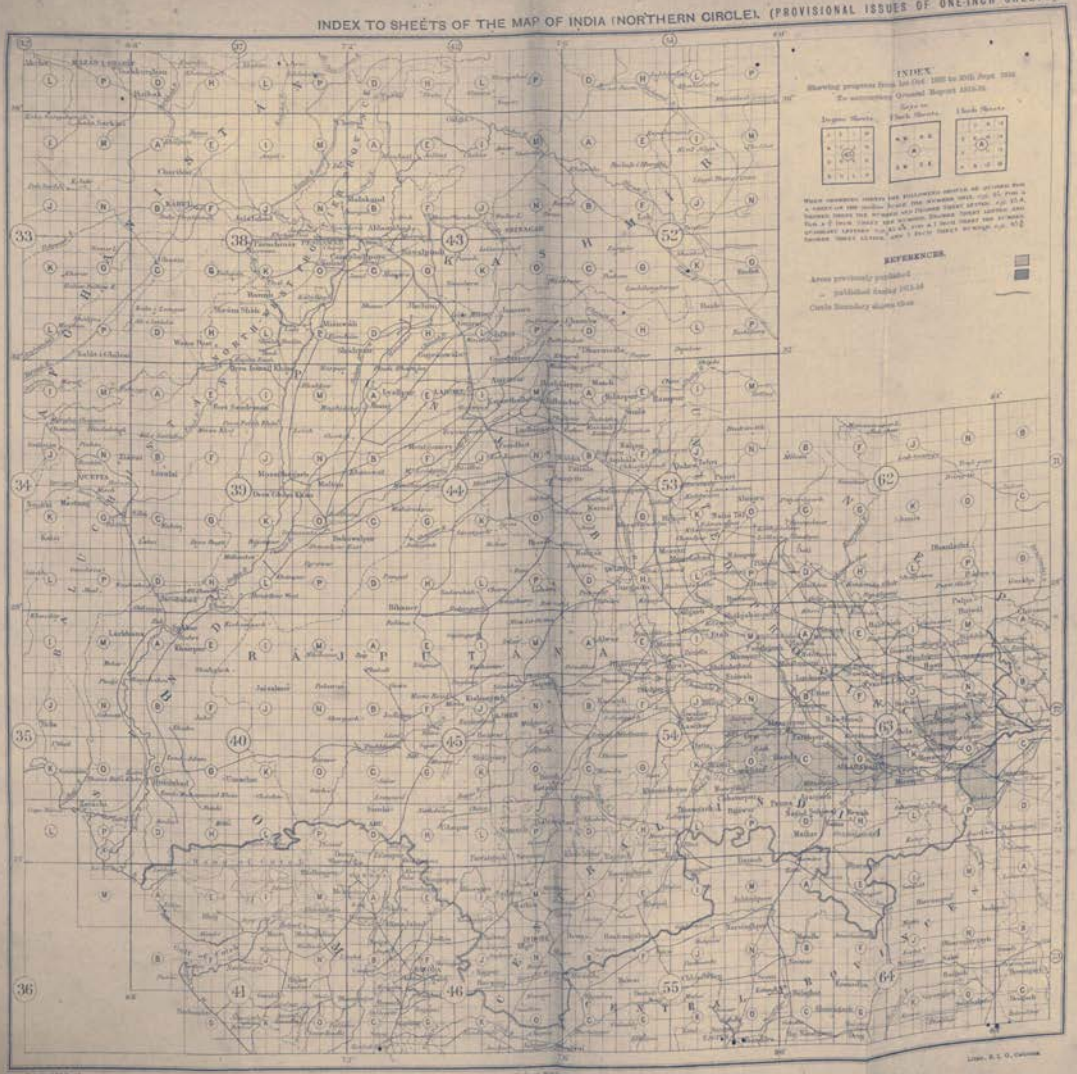

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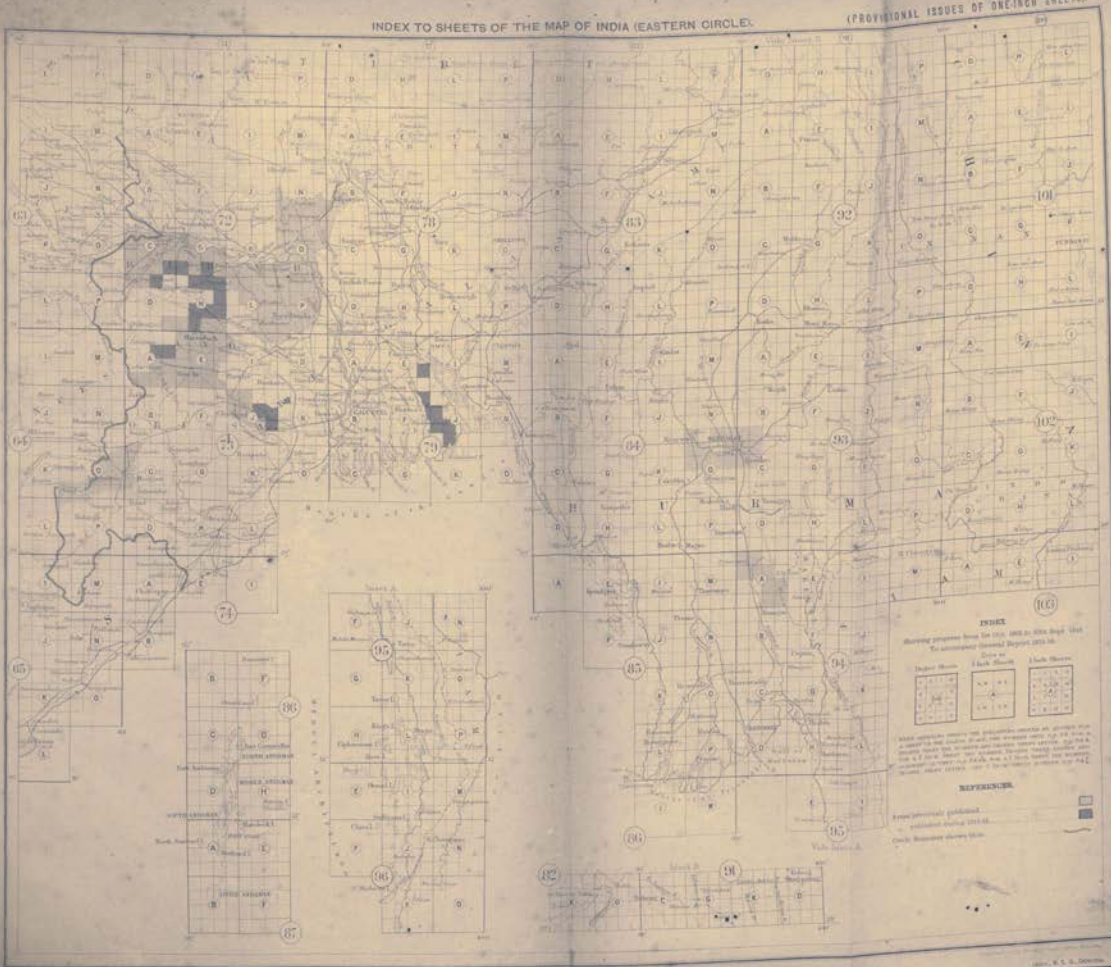

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To accompany General Report 1915-16.

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The half-inch sheets are designated by the number of the sheet on the 1:1,000,000, scale and the letter of the degree sheet in which they fall with the letters N.W., N.E., S.W., or S.E., according to their position as quarters of the degree sheets, entered below the degree sheet letter. Thus the number of half inch sheet containing Jubbulpore is 55 M S.E.

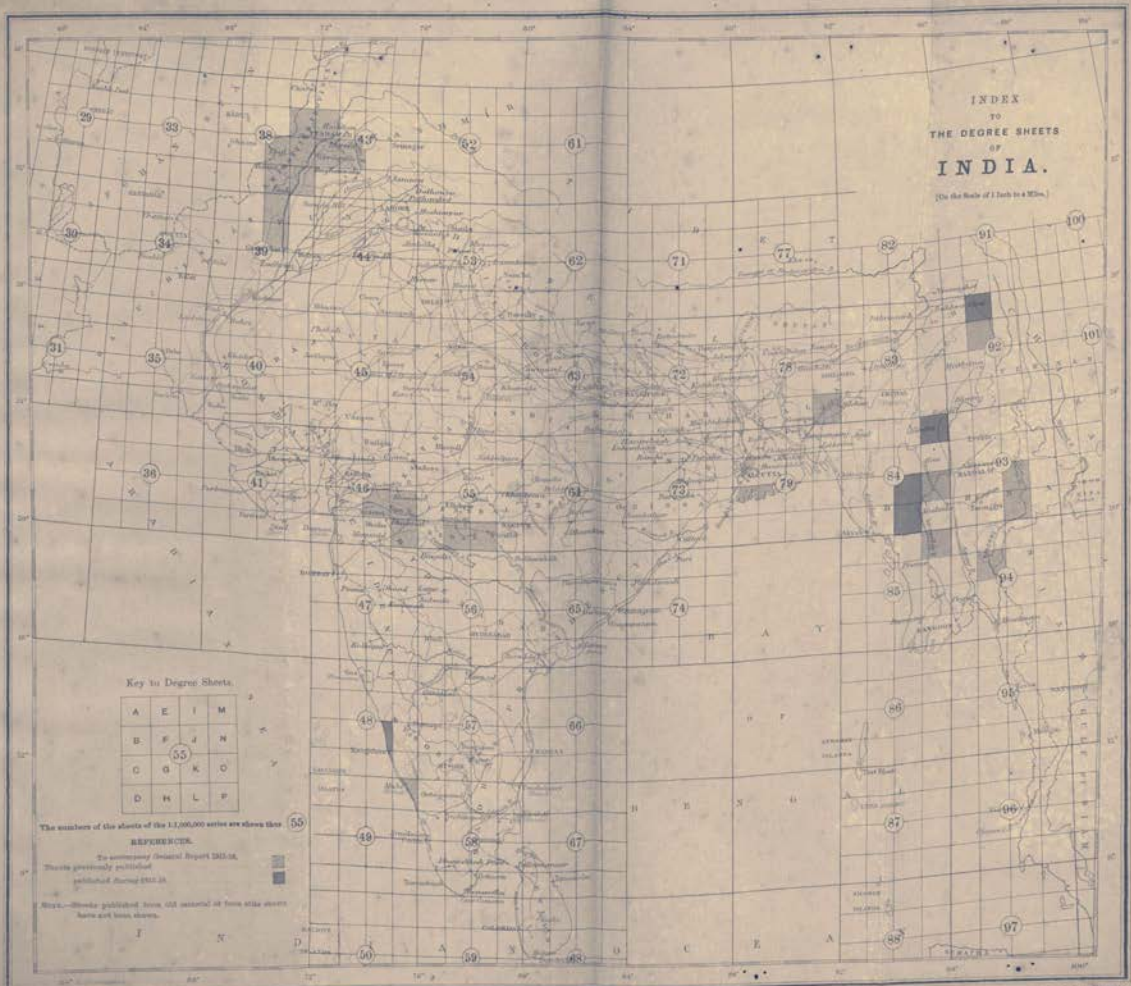
REFERENCE.

Areas previously published
" published during 1915-16

Surv. Gen. Off., Cal.

Litho., S. G. O., Calcutta

HALF INCH SERIES.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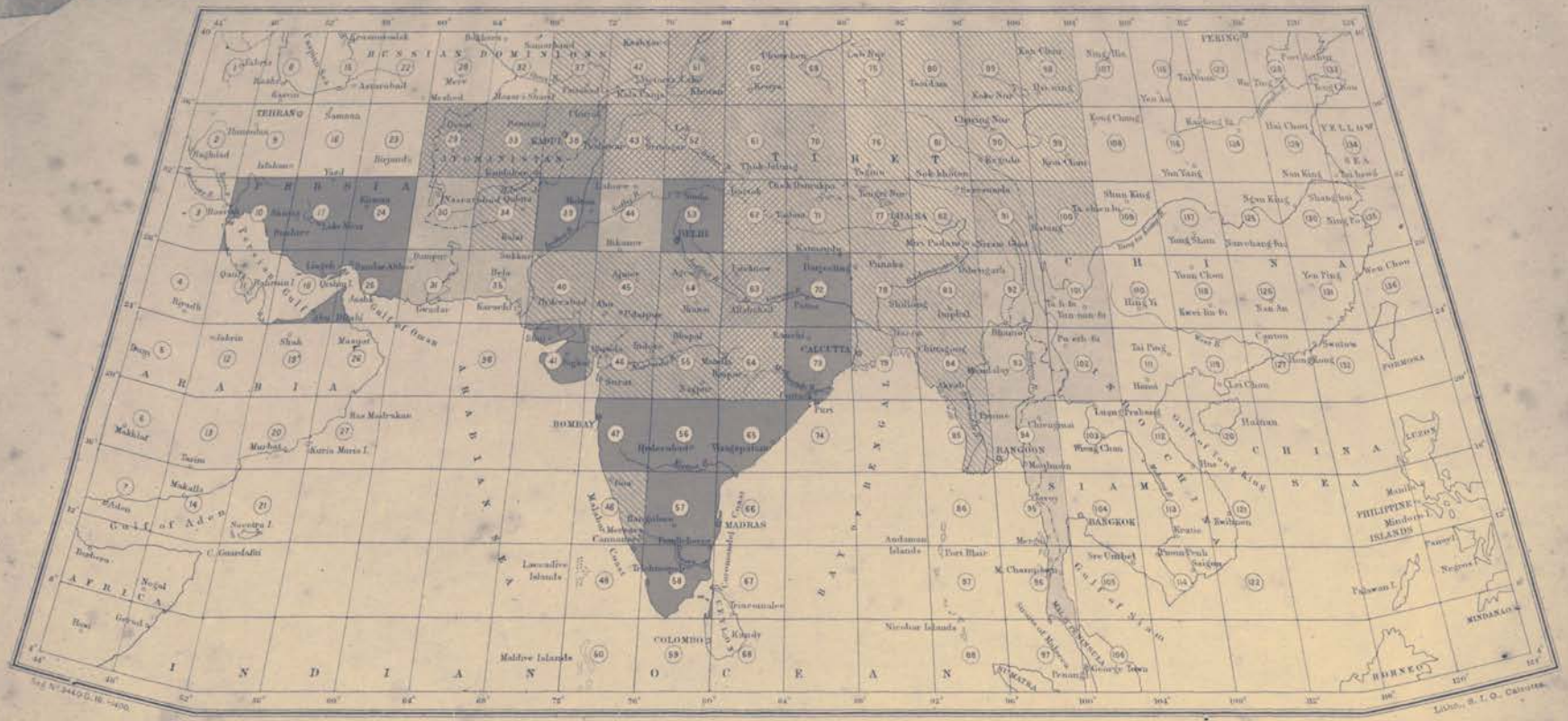
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INDIA AND ADJACENT COUNTRIES SERIES

Scale 1:1,000,000.

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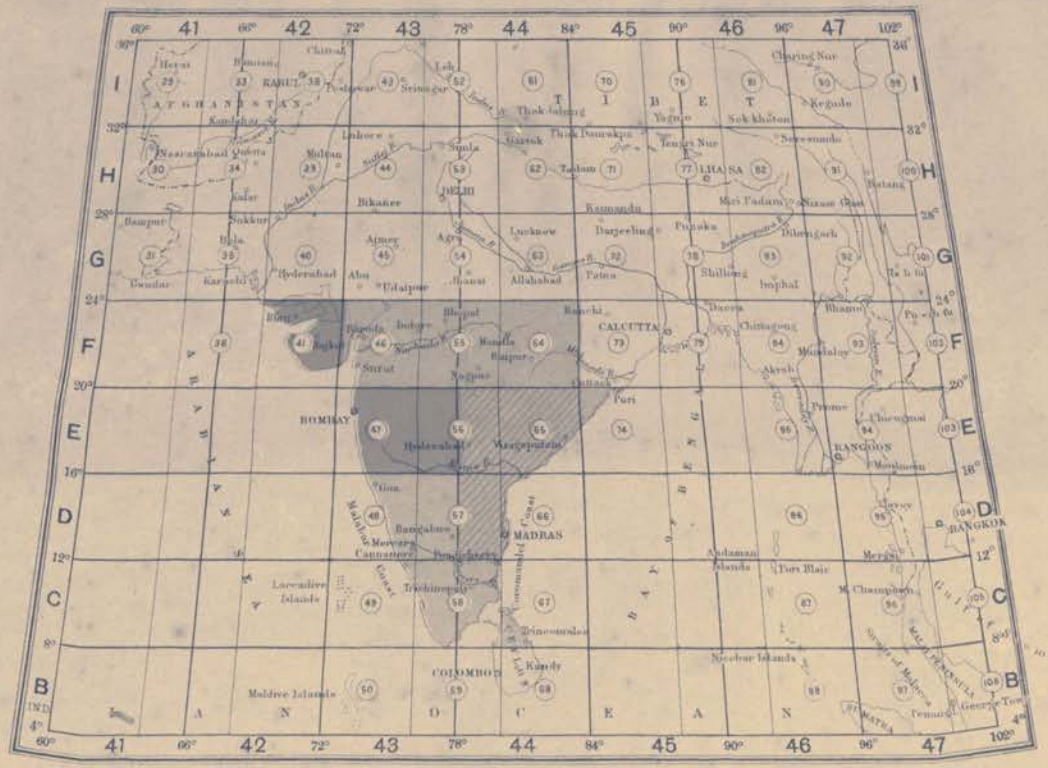
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INTERNATIONAL SERIES

Scale 1:1,000,000.

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Scale of 1:2,000,000 — about 32 miles = 1 inch

Scale 1/2,000,000

Miles 200 0 200 400 600 800 1000 Miles

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under publication

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To accompany General Report 1915-16.

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INDIA
BAY OF BENGAL
ARABIAN SEA

Survey of India.

GENERAL REPORT,

1916–17.

From 1st October 1916
To 30th September 1917.

PREPARED UNDER THE DIRECTION OF

COLONEL SIR S. G. BURRARD, K.C.S.I., R.E., F.R.S.,

SURVEYOR GENERAL OF INDIA.

PRINTED AT THE PHOTO.-LITHO. OFFICE, SURVEY OF INDIA,
CALCUTTA,
1918.

Printed at the
Photographic and Lithographic Office, Survey of India,
14, Wood Street,
Calcutta.

Survey of India.

GENERAL REPORT, 1915-16.

ERRATUM.

Page 15, para. 34, line 2—

For "4-inch" *read* "2-inch".

Survey of India.

GENERAL REPORT,

1916—17.

From 1st October 1916
To 30th September 1917.

PART 1.—GENERAL REMARKS.

I.—INTRODUCTION.

1. The main parts of this report, as shewn in the "Contents" on the opposite page, are *Part 2—Work of Field Parties, &c.*, summarising the operations of the field parties, grouped under appropriate headings; and *Part 3—Office Work*, which gives a brief account of the year's progress in the head-quarters and other offices. Fuller details of these operations are being published in Volume XI of the "Records of the Survey of India."

2. An abstract showing the progress of the topographical programme assigned to the department in 1905, may be found in Table II on page 9. From this it will be seen that the out-turn of topographical survey during the current year was 32,750* square miles; and that this brings the total progress since 1905 to 471,583* square miles, leaving 1,350,017 square miles still to be done.

3. The first three Index maps, at the end of the report, show the progress of this topographical programme both in survey and in publication in the three circles, while the remaining eleven indexes show the progress in publication of the various series of maps appertaining to the scheme, and also the main framework of triangulation on which the survey of India is based.

4. Table IV on page 34 gives a list of the new publications of the Calcutta Offices during the year. A complete list of departmental publications, apart from maps, may be found in the annual "Records of the Survey of India"; and lists of new maps are published quarterly by the department, as well as in the monthly "Notes of the Survey of India."

5. Progress in the Trigonometrical Survey can only be assessed by a study of the "Records of the Survey of India" and the special publications issued at Dehra Dūn. The General Report can attempt little more than a brief abstract of the *locale* and nature of the different operations.

*This however excludes 431 square miles previously surveyed on a smaller scale.

6. **The following events are notified:—**

(*a*) Two Imperial Officers have reverted from temporary military duty and a third officer, who also reverted, has since been recalled to military duty. Four Provincial Officers have reverted from military duty.

(*b*) Owing to the shortage of officers the field work of the whole department was again considerably curtailed.

(*c*) The Survey party under an Imperial Officer which accompanied the field-force in Mesopotamia continued survey operations there.

(*d*) A Survey party under an Imperial Officer was sent to work with the Russian Forces in Western Persia.

(*e*) Another Survey party under an Imperial Officer was ordered to carry out survey operations in Persia.

(*f*) A Survey detachment in charge of a Provincial Officer was sent to Salonika to serve under an Imperial Officer on military duty there.

(*g*) A Survey detachment under a Provincial Officer was attached to the Waziristān Field Force from June to August 1917.

(*h*) An officer of the Upper Subordinate Service was employed on the Makrān Border Mission from November 1916 to April 1917.

(*i*) The Mathematical Instrument Office assisted in receiving, registering and valuing binoculars offered by the public in response to the appeal of His Excellency the Commander-in-Chief in India.

(*j*) A standing Committee of Adjustment was formed to deal with the estates of deceased Military Officers of the Survey of India.

(*k*) Tide Tables for the Port of Basrah, containing predictions of high and low water from 1st September 1917 to 31st December 1918, were prepared from tide-pole readings supplied by the General Staff and sent to the Director of Inland Water Transport, Basrah.

(*l*) The Government of India have asked the Survey Department to make a resurvey of the Mayo Salt Mine at Khewra and this will be undertaken during season 1917-18.

(*m*) A piece of land has been acquired in Dehra Dūn as the site of the new Head Quarter Offices to take the place of those now located in Calcutta.

(*n*) The Royal Geographical Society of London awarded the Murchison Grant for 1917 to Rai Bahadur Lal Singh in recognition of his valuable work in Central Asia under Sir Aurel Stein.

II.—ADMINISTRATION AND PERSONNEL.

7. The actual cost of the department for the financial year ending 31st March 1917 and of the 2 previous years is shown below:—

	1914-15.	1915-16.	1916-17.	REMARKS.
	Rs.	*Rs.*	*Rs.*	
Gross actual cost ...	33,32,541	30,08,348	**33,16,541***	
Deduct receipts and credits	9,48,397	8,35,339	**15,04,386***	* These figures are not final.
Net actual cost ...	23,84,144	21,73,009	**18,12,155***	

8. Colonel Sir S. G. Burrard, K.C.S.I., R.E., F.R.S. administered the department throughout the year.

9. In the Imperial Service Brevet-Major (Temporary Lieutenant-Colonel) A. A. Chase, D.S.O., R.E., died on 11th March from wounds received in action. Captain E. B. Cardew, R.E., who had been reported as wounded and missing on 26th September 1915 was reported as having been killed in action presumably on or after the 25th idem. The number of Imperial Officers temporarily reverted to military duty on account of the war at the end of the Survey year is 28* and the total casualties to date in killed, or died of wounds are 8. Colonel R. A. Wauhope, C.B., C.M.G., C.I.E., R.E., (Retired), has been re-employed temporarily from 1st June 1916.

In the Provincial Service Messrs. A. Ewing, M. Gastaud, H. G. Shaw and F. B. Powell retired, of whom the three first named officers have been re-employed; Mr. P. Kennegy resigned. Mr. T P. Dewar who was employed under the Government of Burma has returned to the Survey of India. The number of officers of the Provincial Service on deputation to military duty at the end of the Survey year is 15. Of the total number of officers accepted by the Army Department one has been killed in action and five have reverted to the Survey of India.

In the Upper Subordinate Service 3 officers retired, 2 probationers resigned, 8 probationers were confirmed, 1 probationer was appointed and 2 surveyors and 1 computer were promoted into this service from the Lower Subordinate Service.

The total strength of the department at the close of the Survey year was 46* Imperial Officers, 116† Provincial Officers and 54 Upper Subordinates besides specialists, clerks, lower subordinates and menials: but the number of officers of the first two services actually employed in the department were 18 Imperial Officers and 101† Provincial Officers including those attached to Overseas Survey Parties, the remainder being on military duty.

10. The Sind-Sāgar Party was formed for the execution of rectangulation as a basis for the Punjab Government's Sind-Sāgar Canal and Colonization Project, No. 4 Party being amalgamated with this party.

No. 20 Party was transferred from the administrative control of the Superintendent, Northern Circle and was placed under that of the Superintendent, Southern Circle.

* Including 2 officers who were on deputation to the Government of Bengal.
† Excluding officers re-employed.

11. The following Honours were conferred on members of the department during the year :—

Companion of the Order of the Indian Empire.—	Brevet.-Colonel F. W. Pirrie, I.A.
Companions of the Distinguished Service Order.—	Major A. A. McHarg, R.E. Major K. W. Pye, R.E. Major H. T. Morshead, R.E.
Bar to the Distinguished Service Order.—	Major S. W. S. Hamilton, D.S.O., R.E.
Awarded the Military Cross.—	Major M. N. MacLeod, R.E., Captains K. Mason, R.E., and H. E. Roome, R.E.
Bar to the Military Cross.—	Brevet-Major F. P. Nosworthy, M.C., R.E.
Awarded the Order of St. Stanislas, 3rd class with Crossed Swords.—	Major A. A. McHarg, D.S.O., R.E.
Promoted to Brevet-Colonel.—	Lieutenant-Colonel F. W. Pirrie, I.A.
Promoted to Brevet-Lieutenant-Colonel.—	Major C. P. Gunter, R.E.
Promoted to Brevet-Major.—	Captains A. A. Chase, D.S.O., R.E. and F. P. Nosworthy, M.C., R.E.
Mentioned in despatches.—	Brevet-Colonel F. W. Pirrie, C.I.E., I.A. (fourth time). Major G. A. Beazeley, R.E. Major H. Wood, R.E. Brevet-Lieut.-Colonel C. M. Browne, D.S.O., R.E. (third time). Captain E. C. Baker, R. E. (died of wounds). Major H. J. Couchman, M.C., R.E. Major H. T. Morshead, D.S.O., R.E. Captain G. F. T. Oakes, R.E. (died of wounds). Brevet-Major (Temporary Lieut.-Colonel) A. A. Chase, D.S.O., R.E. (twice during the year) —since killed. Brevet-Major F. P. Nosworthy, M.C., R.E. (twice). Mr. A. J, Booth. Mr. Laltan Khan (second time).

The following draftsmen of the Army Section of No. 6 Drawing Office (Simla) have been promoted in recognition of their services in India in connection with the war :—

Conductor R. Graham to be Assistant Commissary with the honorary rank of Lieutenant.

Sub-Conductor W. Smith to be Conductor.

12. The following table shows the distribution of officers during the year: The names of officers on deputation to local Governments or military duty are omitted. Several names occur more than once on account of transfers from one office to another :—

TABLE I—DISPOSITION OF OFFICERS, 1916-17.

SURVEYOR GENERAL OF INDIA—Colonel Sir Sidney G. Burrard, K.C.S.I., R.E., F.R.S.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Surveyor General's Office.	Major L. C. Thuillier, I.A.			
No. 6 Drawing Office, Simla.	Major C. J. Arbery	Mr. Bhani Ram Verma „ Asmat-ullah Khan, K.S. „ A. B. Hunter		5 European Draftsmen. 4 Printers. 3 Clerks. 20 Indian Draftsmen.
Basrah Survey Party	Bt.-Colonel F. W. Pirrie, C.I.E., I.A. Major G. A. Beazeley, R.E. Captain W. E. Perry, R.E.	Mr. J. McCraken „ F. C. Pilcher „ W. H. Strong „ A. J. Booth „ J. C. St. C. Pollett	Mr. Nanak Chand Puri „ Bhamba Ram „ Annada Prasad Ghosh	27 Surveyors, &c.
Persian Survey Party.	Major E. T. Rich, R.E.	Mr. A. F. Murphy	Mr. Sher Jang, K.B.	4 Surveyors.
Western Persia Survey Party.	Major H. McC. Cowie, R.E. Captain W. E. Perry, R.E.	Mr. D. K. Rennick	Mr. Hamid Gul „ Lattan Khan	4 Surveyors.
Salonika Survey Detachment.		Mr. H. B. Simons	Mr. Jamna Prasad, K.S.	8 Surveyors.

SUPERINTENDENT, MAP PUBLICATION—*Lieut.-Colonel W. M. Coldstream, R.E. (Temporarily reverted to military duty).* Lieut.-Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Map Publication Office, Calcutta.		Mr. M. Gastand		
No. 1 Drawing Office, Map Record and Issue Office and Engraving Office, Calcutta.	Major H. L. Crosthwait, R.E. Lieut.-Colonel A. Mears, I.A.	Mr. P. Williams „ M. C. Petters „ Jagdamba Prasad „ Abinash Chunder Bose „ C. West „ P. Simpson „ Priya Nath Sur „ D. K. Rennick „ A. A. Graham „ T. F. Kitchen „ H. H. P. Butterfield „ Jiya Lal Salgal		
Photo.-Litho. Office, Calcutta.	Major H. McC. Cowie, R.E. Captain F. J. M. King, R.E. „ C. G. Lewis, R.E.			
Mathematical Instrument Office, Calcutta.	Mr. T. A. Ferrier			
Bengal & Bihar & Orissa Drawing Office, (Imperial Standard Mapping Section).		Mr. E. G. Hardinge „ P. Simpson		

SUPERINTENDENT, NORTHERN CIRCLE—Lieut.-Colonel C. L. Robertson, C.M.G., R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 3 Drawing Office, Mussoorie.		Mr. J. A. Freeman „ E. B. West	Mr. Imam Din	30 Draftsmen, &c.
No. 1 Party, *Kashmir and Jammu State, Punjab and N. W. F. Province.*		Mr. B. R. Hughes „ G. J. S. Rae „ H. P. D. Morton „ P. A. T. Kenny „ R. C. Hanson	Mr. Sher Jang, K.B. „ Natha Singh, K.S. „ Hamid Gul „ Jagdeesh Prasad Vastav	36 Surveyors, &c.
No. 2 Party, *Punjab, Rājputāna and Delhi Province.*		Mr. T. W. Babonau „ F. B. Powell „ R. E. Saubolle „ J. H. Johnson „ J. A. Calvert	Mr. Chuni Lal Kapur „ Ghulam Hasan	26 Surveyors, &c.
No. 3 Party, *United Provinces and Punjab.*		Mr. H. H. B. Hanby „ E. J. Biggie „ A. M. Talati, L. C. E. „ H. T. Hughes „ G. E. R. Cooper „ Moqimuddin	Mr. Muhammad Husain „ Amir Abdul Salam Matlub Ahmad	54 Surveyors, &c.
No. 4 Party, *United Provinces.*	Major H. L. Crosthwait, R.E.	Mr. E. W. Biggie „ J. A. Freeman „ J. C. C. Lears „ E. C. O'Sullivan „ F. J. Grice „ Duni Chand Puri	Mr. Mohammad Husain Khan „ Daulat Ram Vohra	23 Surveyors, &c.
Sind-Sāgar Paty, *United Provinces.*	Major H. L. Crosthwait, R.E.	Mr. J. C. C. Lears „ F. J. Grice	Mr. Mohammad Husain Khan „ Nabidad Khan	18 Surveyors, &c.
Riverain Detachment, *Punjab.*		Mr. Maya Das Puri, K.S.	Mr. Paras Ram „ Jamna Prasad, K.S. „ Mahomed Lutf Ali „ Lakshmi Dutt Joshi „ Vidya Dhor Chopra	74 Surveyors, &c.
Tank Survey Detachment, *Waziristān.*		Mr. P. A. T. Kenny „ Duni Chand Puri		2 Surveyors.

TABLE I—(Continued).—DISPOSITION OF OFFICERS, 1916-17.

SUPERINTENDENT, SOUTHERN CIRCLE—Colonel T. F. B. Renny-Tailyour, C.S.I., R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 4 Drawing Office, Bangalore.		Mr. J. H. Nichol „ F. P. Walsh „ S. F. Norman	Mr. B. V. Narayana Rao	33 Draftsmen, &c.
No. 5 Party, *Berār, Central India and Central Provinces.*		Mr. P. R. Anderson „ C. West „ Haji Abdul Rahim, K.B. „ F. H. Grant	Mr. Damodar Khadilkar	22 Surveyors, &c.
No. 6 Party, *Bombay, Hyderābād and Madras.*		Mr. J. O'B. Donaghey „ E. A. Meyer „ F. C. Pilcher „ Munshi Lal, B.A. „ F. W. Smith „ M. S. Ganesa Aiyar „ K. S. Gopalachari, B.A.	Mr. Eknath Battu „ Ram Narayan Hastir „ Nabidad Khan „ Masud Khan	38 Surveyors, &c.
No. 7 Party, *Madras.*		Mr. W. M. Gorman „ H. B. Simons „ V. W. Morton „ H. H. P. Butterfield „ B. T. Wyatt „ N. S. Hariharа Iyer	Mr. Abdul Hakk, K.S. „ Kodandera Mandanna „ P. S. Vengusvami „ Shib Lal „ H. Narasimhamurti Rao „ Shaikh Muhammad Salik „ E. N. Natesan, B.A. „ Pulin Behari Roy „ Jitendra Mohan Makerji	39 Surveyors, &c.
No. 8 Party, *Madras.*		Mr. W. F. E. Adams „ M. Mahadeva Mudaliar, M.A.	Mr. Anantarao Dhondiba Mandhre, K.S. „ K. Narayanaswami Chetti	26 Surveyors, &c.
No. 20 Party, *Rāwalpindi, Chitrāl, Drosh, Ghairat, Jhelum, Sialkot, Topa, Dharmsāla, Chaman, Jhānsi, Deoli, Neemuch, Nasīrābād, Ahmadnagar, Dazinda, Jandola, Jasta and Zam Cantonments.*		Mr. A. Ewing „ O. D. Jackson	Mr. Dharma	25 Surveyors, &c.
Training Section, *Mysore.*		Mr. S. S. McA'F. Fielding „ S. P. Norman	Mr. Hari Ram Chandra Jogalekar „ G. K. Narasimha Ayyangar „ K. R. Venkata Rao „ Afraz Gul Khan	11 Surveyors, &c. and Pupils. *Under training.*

SUPERINTENDENT, EASTERN CIRCLE—Lieut.-Colonel R. T. Crichton, C.I.E., I.A.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
No. 5 Drawing Office, Shillong.		Mr. J. H. S. Wilson „ E. Claudius		24 Draftsmen, &c.
No. 9 Party, *Bengal, Bihār and Orissa.*		Mr. J. Smith „ Dhani Ram Verma „ A. B. Hunter „ B. C. Newland „ Amar Krishna Mitra	Mr. Ram Singh „ Amulya Charan Ghosh „ Gopal Lal Mitra	27 Surveyors, &c.
No. 10 Party, *Upper Burma.*	Major E. T. Rich, R.E.	Mr. M. C. Petters „ W. G. Jarbo „ H. H. Creed „ A. V. Dickson „ Dhirendra Nath Banerjee, L.C.E.	Mr. Hayat Muhammad, K.S. „ Maung Kyaw Nyein „ Dhirendra Nath Saha „ Ram Prasad, R.S.	23 Surveyors, &c.
No. 11 Party, *Upper and Lower Burma.*		Mr. J. O. Greiff „ C. E. C. French „ O. J. H. Hart „ T. P. Dewar „ C. O. Picard	Mr. Lachman Daji Jadu, R.B. „ Dalbir Rai „ Pratul Chandra Sen Gupta, B. Sc.	30 Surveyors, &c.
No. 12 Party, *Assam.*	Lieut.-Colonel A. Mears, I.A.	Mr. H. W. Biggie „ E. G. Hardinge „ Pramadaranjan Ray, R.S. „ E. M. Kenny „ Prafulla Chandra Mitra, B.A.	Mr. Girija Sonker Bagchi	35 Surveyors, &c.

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1916-17.

SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY—Colonel G. P. Lenox-Conyngham, R.E.

	Imperial Officers.	*Provincial Officers.*	*Upper Subordinates.*	*Lower Subordinates, &c.*
Superintendent's Office.	*(Attached)* Colonel R. A. Wisebope, C.B., C.M.G., C.I.E., R.E.	Mr. H. A. Charrier	.....	
Computing Office	Mr. J. deGraaff Hunter, M.A. Major H. McC. Cowie, R.E.	Mr. Hanuman Prasad.....	Mr. Sarat Kumar Mukerji.....	51 Computers, &c.
No. 2 Drawing Office and Forest Map Office, Dehra Dun.	Major H. H. Turner, R.E.	Mr. O. C. Ollenbach ,, C. C. Byrne ,, H. G. W. Stotesbury ,, O. N. Pushong ,, F. H. Grant ,, F. B. Kitchen ,, Abdul Karim, B.A. ,, F. J. Grice	Mr. Lal Singh, R.B. ..... ,, Ram Singh, R.S.	89 Draftsmen, &c.
No. 13 Party, ... *(Astronomical).*	Colonel G. P. Lenox-Conyngham, R.E. Major H. H. Turner, R.E. Major H. McC. Cowie, R.E.	.....	.....	2 Computers, &c.
No. 14 Party, ... *(Pendulum).*	Colonel G. P. Lenox-Conyngham, R.E. Major H. McC. Cowie, R.E.	.....	.....	2 Computers, &c.
No. 15 Party, ... *(Triangulation).*	Mr. J. deGraaff Hunter, M.A....	Mr. H. G. Shaw ..... ,, L. Williams ,, Raj Bahadur Mathur, B.A.	Mr. Jugal Behari Lal.....	9 Computers, &c.
No. 16 Party, ... *(Tidal).*	.....	Mr. Syed Aulad Hosscin, B.E. ,, O. C. Ollenbach ,, Syed Zille Hasnain	.....	20 Computers, &c.
No. 17 Party, ... *(Levelling).*	.....	Mr. H. G. Shaw ..... ,, D. H. Luxa ,, Raj Bahadur Mathur, B.A. ,, G. A. Norman ,, Abdul Karim, B.A. ,, F. J. Grice ,, N. N. Chuckerbutty, L.C.E.	Mr. Satish Chandra Mukerjee	12 Recorders, &c.
No. 18 Party, ... *(Magnetic).*	.....	Mr. E. C. J. Bond ..... ,, Rama Prasad Ray, B.A. ,, N. R. Mazumdar ,, Raj Bahadur Mathur, B.A.	Mr. Karuna Kumar Das, B.A. ,, Bidhu Bhusan Shome	2 Magnetic Observers. 12 Computers, &c.
No. 19 Party, ... *(Base Line).*	.....	Mr. E. C. J. Bond ,, O. N. Pushong	.....	3 Computers, &c.

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PART 2.—WORK OF FIELD PARTIES, &c.

I.—TOPOGRAPHICAL SURVEYS.

13. The two following tables show respectively the progress of the topographical programme assigned to the department in 1905 and the out-turns and costs of different parties during the year under report. They are followed by brief descriptions of the work of each topographical party.

In 1913, the Secretary of State sanctioned a scheme for the reduction of the scale of survey of certain sparsely populated areas of India. This will greatly reduce the area of survey on the one-inch scale and consequently accelerate the rate of progress of topographical surveys shewn in Table II below. In order to give a better idea of what work actually lies before the department, it may be remarked that of the area remaining for survey about 600,000 square miles are likely to be surveyed on the half-inch or smaller scale.

Table II.—Progress of Topographical Surveys since 1905.

Survey year.	Scales of Survey.	Northern Circle.	Southern Circle.	Eastern Circle.	TOTALS.
		Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-06 ...	Mostly 2-inch and 1-inch	6,278	1,660	10,322	18,260
1906-07 ...	ditto ...	7,519	7,666	8,659	23,844
1907-08 ...	ditto ...	14,530	9,256	12,431	36,217
1908-09 ...	ditto ...	18,624	12,526	11,542	42,692
1909-10 ...	Mostly 1-inch ...	23,833	12,532	9,736	46,101
1910-11 ...	ditto ...	27,528	13,171	9,218	49,917
1911-12 ...	ditto ...	23,852	9,115	10,654	43,621
1912-13 ...	Mostly 1-inch and ½-inch	28,192	13,349	11,836	53,377
1913-14 ...	ditto ...	25,052	15,844	14,890	55,786
1914-15 ...	ditto ...	12,334	19,286	5,056	36,676
1915-16 ...	ditto ...	8,168	17,243	6,931	32,342
1916-17 ...	ditto ...	11,689	11,338	9,723	32,750
Total Areas completed to date ...		207,599	142,986	120,998	471,583
Approximate areas for the whole topographical programme.		750,000	542,800	528,800	1,821,600
Approximate areas remaining for survey.		542,401	399,814	407,802	1,350,017

Table III.—OUT-TURNS and COSTS of Topographical Surveys, 1916-17.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS. Areas on each Scale.	OUT-TURNS. Totals on all Scales.	COST OF SURVEY AND MAPPING. Total costs.	COST OF SURVEY AND MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	**NORTHERN CIRCLE.**
No. 1 Party—*Kashmīr, Jammu State, Punjab and North-West Frontier Province.*						
Irrigated plains and barren stony waste.	4-inch Original Military Survey	208				
Mountainous with well-wooded valleys and intricate foot hills.	1-inch Original Survey ...	2,677				
Cultivated plains, partly canal irrigated.	1-inch Resurvey	1,056	4,219	1,02,700 (a)	24·3	(a) Includes Rs. 450 on account of establishment employed on mapping work in Basrah Survey Party but excludes Rs. 158 debitable to the Tharoch State.
Broken hilly ground and well-wooded	1-inch Supplementary Survey ...	278				
No. 2 Party—*Punjab, Rājputāna and Delhi Province.*						
Cultivated plains and sand hills with rocky outcrops.	1-inch Revision Survey ...	199				
	1-inch Original Survey ...	1,092				
	½-inch Original Survey ...	1,622	2,981	67,568 (b)	22·7	(b) Excludes Rs. 85 debited to the Executive Engineer, Lower Bari Doāb Canal.
Cultivated plains and rocky outcrops.	4-inch Revision Survey ...	64				
Alwar town	1½-inch Original Survey ...	4				
No. 3 Party—*United Provinces and Punjab.*						
Open and wooded plains and wooded hills.	1-inch Resurvey	2,619				
Wooded hills	2-inch Original Survey ...	11				
Open plains and undulating	3-inch Original Special Survey...	56				
Ditto ditto	3-inch Supplementary Special Survey.	56	2,863	84,020 (c)	29·3	(c) Excludes Rs. 25,170 debitable to the Forest Department and Rs. 1,989 debitable to the Settlement Officer, Gorakhpur.
Densely wooded hills	4-inch Original Special Forest Survey.	118				
Wooded hills	4-inch Supplementary Special Forest Survey.	3				
No. 4 Party—*United Provinces.*						
Plains fairly dense with mango topes	1-inch Resurvey	1,329	1,329	41,987 (d)	31·6	(d) Includes cost of 5,295 square miles of mapping for village boundary editions of 1-inch maps.
Tank Survey Detachment—*Waziristān.*						
Rocky barren hills from 1,200 to 8,000 feet in altitude.	1-inch Original Survey ...	297	297	6,745 (e)	22·7 (e)	(e) Of Plane-tabling only.
TOTALS, NORTHERN CIRCLE:—		**11,689 sq. m.**		**Rs. 3,03,020**		**Cost-rate 25·9**
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	**SOUTHERN CIRCLE.**
No. 5 Party—*Berār, Central India and Central Provinces.*						
Well wooded cultivated plains	1-inch Original Survey ...	274	831	25,983 (f)	31·3	(f) Excludes Rs. 13,069, cost of ½-inch mapping.
Wooded intricate hills	1-inch Revision Survey ...	557				
No. 6 Party—*Bombay, Hyderābād and Madras.*						
Varied, mostly undulating	½-inch Original Survey ...	5,045				
Undulating and cultivated	1-inch Original Survey ...	1,857	7,333	1,08,784	14·8	(g) This area had been previously surveyed on a smaller scale.
Wooded flat-topped hills	1½-inch Resurvey ...	431 (g)				
No. 7 Party—*Madras.*						
Varied	1-inch Original Survey ...	3,108				
Wooded intricate hills	1-inch Supplementary Survey	24	3,312	1,05,009	31·7	
Wooded, undulating and hilly	2-inch Original Survey ...	65				
Ditto ditto	4-inch Original Survey ...	115				
No. 8 Party—*Madras.*						
High wooded and low intricate hills	1-inch Original Survey ...	293	293	28,638 (h)	97·7	(h) Excludes Rs. 21,467, cost of ½-inch mapping.
TOTALS, SOUTHERN CIRCLE:—		**11,769 sq. m.**		**Rs. 2,68,414**		**Cost-rate 22·8**

Table III—(Concluded).—OUT-TURNS and COSTS of Topographical Surveys, 1916-17.

PARTY and LOCALITY. Character of Country.	Scale and Class of Survey.	OUT-TURNS. Areas on each Scale.	OUT-TURNS. Totals on all Scales.	COST OF SURVEY AND MAPPING. Total costs.	COST OF SURVEY AND MAPPING. Cost-rates.	REMARKS.
		Sq. miles.		*Rs.*	*Rs. per sq. mile.*	EASTERN CIRCLE.
No. 9 Party—*Bengal, Bihār and Orissa.*						
Flat and cultivated plains in Bengal, wooded hills and plains in Bihār and Orissa.	1-inch Original Survey ...	1,681	1,681	42,560 (*l*)	25·3	The area surveyed in Bihār and Orissa has not been mapped. (*l*) Includes costs of computations and preparation of traverse charts but excludes Rs. 20,592 cost of half inch mapping and Rs. 416 cost of Sibsāgar-Darrang boundary survey.
No. 10 Party—*Upper Burma.*						
High hills densely wooded	... ½-inch Original Survey ...	2,140	3,454	1,36,499 (*j*)	39·5	(*j*) Includes Rs. 10,384 cost of Instruction camp.
Ditto ditto	... 1-inch Original Survey ...	1,238				
Ditto ditto	... 1-inch Revision Survey ...	16				
Ditto ditto	... 2-inch Original Survey ...	60				
No. 11 Party—*Upper and Lower Burma.*						
Densely wooded hills and swamp vegetation.	1-inch Original Survey ...	2,213	2,709	1,72,244 (*k*)	63·6	(*k*) Includes cost of Maymyo Drawing Office.
Densely wooded hills ...	... 1-inch Revision Survey ...	318				
High hills densely wooded	... 2-inch Original Survey ...	178				
No. 12 Party—*Assam.*						
Plains, partly under cultivation and partly densely wooded.	1-inch Original Survey ...	1,747	1,879	1,19,919	63·8	
Densely wooded plains and low hills.	2-inch Original Survey ...	132				
TOTALS, EASTERN CIRCLE:—		9,723 sq. m.		Rs. 4,71,222	Cost-rate 48·5	
GRAND TOTALS:—		33,181 sq. m.		Rs. 10,42,656	Cost-rate 31·4	

NORTHERN CIRCLE (*vide* Index map No. 1).

14. No. 1 Party.—This party surveyed an area of 4,011 square miles on the scale of 1 inch = 1 mile in parts of Kashmīr—Jammu and Chamba States, and in the districts of Gurdāspur, Hoshiārpur and Kāngra of the Punjab.

The country surveyed varied from 850 to 15,300 feet in altitude, and consisted of well cultivated plains and intricate foot hills, and mountainous well-wooded valleys.

An area of 208 square miles was surveyed on the scale of 4 inches = 1 mile in the Peshāwar district of the North-West Frontier Province for military purposes (*vide* page 17).

15. No. 2 Party.—This party surveyed a total area of 1,291 square miles on the scale of 1 inch = 1 mile in the Gurgaon district, and the Nābha, Jīnd and Patiāla States, of the Punjab, and in the Alwar, Bharatpur and Jaipur States of the Central India Agency; also areas of 4 square miles on the 1½-inch scale in the State of Alwar, 1,622 square miles on the half-inch scale in the States of Alwar, Bharatpur and Jaipur, and 64 square miles on that of 4 inches = 1 mile of Imperial Delhi and Delhi New Cantonment.

The country surveyed was hilly with a good number of sand hills.

In addition, triangulation and traversing of 950 square miles and 189 linear miles respectively were carried out for current one-inch detail survey in portions of Alwar, Bharatpur, Jaipur and Patiāla States.

16. No. 3 Party.—This party surveyed a total area of 2,751 square miles in the Budaun, Bareilly, Garhwāl, Morādābād, Nainī Tāl, Pilibhīt and Shāhjahānpur districts of the United Provinces and Rāmpur State (Rohilkhand). Of this area, 2,619 square miles were resurveyed on the one-inch scale, 11 square miles were surveyed on the two-inch scale, 3 square miles (of the Mukteswar reserved forest) were supplemented on the four-inch scale, and 118 square miles were surveyed on the four-inch scale. The two last mentioned were special forest surveys (*vide* page 16). In addition, 1,588 square miles and 588 linear miles were respectively triangulated and traversed in advance with the object of extending survey operations into these areas in subsequent years.

The nature of the country varied in character and may conveniently be divided into three belts; fairly open and well cultivated plains in the south, densely wooded hills in the north, with the well-wooded and low-lying tracts of the Tarai and Bhābar in the centre.

An area of 112 square miles was also surveyed in the Attock district of the Punjab, (*vide* page 17).

17. No. 4 Party.—A section of this party surveyed an area of 1,329 square miles on the scale of 1 inch = 1 mile in the districts of Gorakhpur and Bastī of the United Provinces in continuation of last year's programme. The continuity of well cultivated fields is broken by village-sites, numerous orchards of mango trees and the treeless and flood-swept tracts on both banks of the Rāptī and Amī rivers. The Rāptī river traverses almost the whole length of country surveyed.

18. Tānk Survey Detachment.—This detachment surveyed an area of 297 square miles in Southern Wazīristān on the scale of 1 inch = 1 mile.

The country surveyed varied from 1,200 to 8,000 feet in altitude, and consisted of barren rocky hills; the only water obtainable lay in a few of the larger *nālas*.

The survey was based on previously executed triangulation.

19. Recess Work.—The fair-mapping of the following numbers of sheets of the current and previous season's survey remained for completion on 30th September 1917 :—

Sheets on the half-inch scale	2
Sheets on the one-inch scale	52
Forest Survey sheets on the two-inch scale	7
Special four-inch surveys for publication on the two-inch and four-inch scales ...	10

The backwardness of fair-mapping has been due partly to the very late return from the field of Nos. 1 and 3 Parties, and partly to the reduction in the establishment of No. 4 Party on amalgamation with the Sind-Sāgar Party. No. 2 Party has failed to deal with its current mapping.

Half-inch mapping from published modern one-inch sheets, or from old trans-frontier half-inch maps, is dealt with on page 39.

20. Particulars of special work done by Nos. 1, 2, 3 and the Sind-Sāgar Parties, and by the Punjab Riverain Detachment, are given on pages 17 and 41.

SOUTHERN CIRCLE (*vide* Index map No. 2)

21. No. 5 Party.—This party surveyed an area of 831 square miles on the one-inch scale in the Akola and Amraotī districts of Berār and in the Betūl and Nimār districts of the Central Provinces, and triangulated an area of 412 square miles in the Hoshangābād district of the Central Provinces and in the Bhopāl State of Central India. The country surveyed consists of jungle-clad hills and of well-wooded, cultivated plains. The majority, including the head-quarters, of the party remained at Bangalore throughout the year and was principally employed on the fair-mapping of half-inch sheets compiled from published sheets of the one-inch map.

22. No. 6 Party.—This party surveyed an area of 7,333 square miles on different scales in the Sholāpur and Bijāpur districts and the Akalkot, Kurandvād and Sāngli States of Bombay and in the Osmānābād, Bīdar, Gulbarga, Medak, Atrāf-i-balda, Nalgonda and Mahbūbnagar districts of Hyderābād, and triangulated an area of 13,280 square miles in the Bijāpur and Dhārwār districts of Bombay, in the Bellary district of Madras and in the Gulbarga, Raichūr, Atrāf-i-balda and Mahbūbnagar districts of Hyderābād. The country surveyed is undulating and highly cultivated in the Bombay area, the Hyderābād portion consists of wooded, rocky hills and scattered boulders interspersed with areas of cultivation and low scrub jungle.

23. No. 7 Party.—This party surveyed an area of 3,312 square miles on various scales in the Nellore, Chittoor and Chingleput districts of Madras, triangulated an area of 6,994 square miles in the Kurnool, Cuddapah, Guntūr and Nellore districts of Madras, and traversed 132

linear miles in the Nellore district. The country surveyed includes a portion of the eastern slopes of the Eastern Ghāts and of the undulating ground extending, in an expanse of wooded and cultivated lands broken at long intervals by detached knolls, from the foot of these Ghāts to the sea coast.

24. No. 8 Party.—This party surveyed an area of 293 square miles on the one-inch scale in the Tinnevelly district and the Travancore State of Madras, triangulated 1,630 square miles in the Madura and Rāmnād districts of Madras, and traversed 258 linear miles in the Tinnevelly district. The country surveyed comprises an unexplored portion of the Pandalam hills; the country is for the most part covered with evergreen forest with dense undergrowth, there are little or no means of communication, and transport and labour are extremely difficult to obtain as men from the low country will not enter this area. The survey was difficult and entailed considerable hardships on the members of the party concerned. The majority, including the head-quarters, of the party remained at Bangalore throughout the year and was principally employed on the fair-mapping of half-inch sheets compiled from published sheets of the one-inch map.

25. Training Section.—This section took the field in the Kolār and Tumkūr districts of Mysore. 3 upper subordinates and 10 lower subordinates received instruction in topographical surveying.

26. Recess Work.—The whole of the area surveyed this year should be fair-mapped by the end of 1917.

27. The report on cantonment surveys, undertaken by No. 20 Party, is entered on page 18.

EASTERN CIRCLE (*vide* Index map No. 3).

28. No. 9 Party.—This party surveyed an area of 1,362 square miles on the one-inch scale in the Murshidābād, Nadiā and Burdwān districts of Bengal, and an area of 319 square miles on the same scale in the Monghyr and Bhāgalpur districts of Bihār and Orissa. The country surveyed in Bengal is low-lying and nowhere is it even 50 feet above sea-level. Except along the Bhāgirathi or Hooghly river and other large streams where villages cluster thickly on both banks, the country consists of large open tracts of rice cultivation sparsely dotted with villages and clumps of trees. In Bihār the general level of the country is 500 feet, but a range of hills rising at its highest point to 1,600 feet crosses the area from south-west to north-east, the hills being forest clad and the plains cultivated in parts with dry cereals chiefly dhal and mustard.

29. No. 10 Party.—This party surveyed an area of 3,454 square miles on different scales in Myitkyinā and Putao districts of Upper Burma and triangulated an area of 4,752 square miles in advance for detail surveys on the scales of one inch and half inch to the mile. The country surveyed was densely wooded and ranged in altitude from 600 feet in the valley of the Mali Hka to 11,300 feet in the Kumon Bum forming the watershed between the Mali Hka and Chindwin rivers. There are no roads and villages over large areas lying along the eastern slopes of Kumon Bum.

30. No. 11 Party.—No. 11 party surveyed a total area of 2,709 square miles, of which 2,213 square miles were on the one-inch scale, 178 square miles on the two-inch, and 318 square miles one-inch revision survey. In the Mergui district and Archipelago 4,075 square miles were triangulated.

The work lay in the valley of the Tenasserim, and the extreme north of the Archipelago in the Mergui district. From the sea littoral to the main watershed, forming the administrative boundary between Burma and Siam, the country varied from dense mangrove swamps intersected by numerous creeks, to steep hills rising to an elevation of 4,000 feet, covered with almost primeval tree growth, intermixed with dense areas of bamboo and cane.

The two-inch survey, and part of the revision, were respectively carried out in the district of Kyaukse, and in the district of Mandalay and the Northern Shan States; the country consisting of well cultivated areas in the latter, and of fairly steep hills densely wooded in the former.

31. No. 12 Party.—This party surveyed 1,747 square miles on the one-inch scale, and 132 square miles of reserved forests on the two-inch scale in the districts of Lakhimpur and Sibsāgar and the North-East Frontier Tract, Central and Eastern Sections. 466 linear miles of traversing, covering an area of 1,111 square miles east of the area surveyed, was also carried out to provide points for detail survey in 1917-18.

Generally speaking the whole area over which survey and traverse operations were extended is well-wooded, tree, cane, and high grass jungle being interspersed with numerous tea gardens and rice cultivation. The country comprises the alluvial plains of the Brahmaputra which is the principal river in the area.

32. Recess work.—There were no arrears of mapping of the previous season's survey on 30th September 1917, but of the current season's survey 6 sheets remain unfinished, these sheets will be completed before 31st December next.

II.—FOREST SURVEYS.

33. Details of the topographical surveys of reserved forests executed by field parties of the Survey of India are given below. The surveys were mostly on the two-inch scale, but in special cases the four-inch and one-inch scales were used. Boundary surveys on the four-inch scale were also made where required.

NORTHERN CIRCLE.

34. Kumaun Forest Circle, United Provinces (*Naini Tal District Forests*).—Twenty-four blocks covering an area of 72·063 square miles in the Peora, Bhowāli, Manora and Barhon Forest Ranges were surveyed on the four-inch scale, and a revision survey on the same scale of 2·906 square miles in the Latauli Block was also carried out for the Imperial Bacteriologist, Mukteswar. Preliminary to future surveys on the four-inch scale an area of 95 square miles was triangulated in advance, and 342 linear miles were traversed.

(*Southern Garhwal Forest Division*).—About 3 square miles were surveyed on the two-inch scale.

SOUTHERN CIRCLE.

35. Madras Forests (*Nellore District*).—Two extensions of the Velikonda Block in the Rāpūr Tāluk and one in the Udayagiri Tāluk covering an area of 114·537 square miles were surveyed on the four-inch scale, and sixteen blocks in the Rāpūr Tāluk, two in the Gūdūr Tāluk and two in the Nellore Tāluk, covering an area of 64·592 square miles were surveyed on the two-inch scale. Theodolite traverses were also carried out along portions of the Velikonda reserve where no traverse data of the Madras Revenue Survey were available.

EASTERN CIRCLE.

36. Assam (*Eastern Forest Circle*).—The Panidihingia, Dirai, Abhaipur, and Sola reserves, covering an area of 86·26 square miles in the Sibsāgar district and the Jokai, Dihingmukh and Dibru reserves covering an area of 45·66 square miles in the Lakhimpur District were surveyed on the two-inch scale. Portions of the boundaries of the Sola, Jokai, Dibru and Upper Dihing (east block) forests were traversed and plots of these will be prepared in due course.

37. Burma (*Northern Forest Circle, Myitkyina Forest Division*).—An area of 59·8 square miles of the Mokso extension which is to form part of the Indawgyi reserve was surveyed on the two-inch scale.

(*Meiktila Forest Division*).—The remaining portion of the Yeyaman reserve covering an area of 177·75 square miles was surveyed on the two-inch scale.

(*Southern Forest Circle, Tenasserim Forest Division*).—An area of 71·16 square miles in the Auckland Bay reserve was surveyed on the one-inch scale, and the survey of the Sandawut Forest was completed, but as the boundary of the reserve has not been demarcated its area cannot be definitely ascertained.

III.—CANTONMENT AND LARGE-SCALE SURVEYS.

38. No. 1 Party.—During the year under report a detachment was employed on military surveys, on the scale of 4 inches = 1 mile, of an area of 208 square miles round Peshāwar, in the North-West Frontier Province.

The country surveyed was for a great part highly irrigated and intersected by numerous branches of the Kābul river, while, on the west, it was a barren stony waste cut up by innumerable ravines.

The fair map, consisting of 6 sheets, each drawn in 2 halves on the scale of survey for publication primarily on that of 2 inches = 1 mile, is at present under preparation in the party.

The cost-rate of survey works out at Rs. 70·7 per square mile, and that of mapping at about Rs. 23 per square mile.

39. No. 2 Party.—This party carried out the first of the biennial revisions of the four-inch maps of Imperial Delhi and the Delhi New Cantonment during the year under report. The area dealt with amounted to 64 square miles. This revision disclosed very considerable changes since the execution of the original survey on the same scale. These changes were due, partly to demolitions and to new lays-out and new construction, and partly to extensive levelling operations. These latter necessitated an entire recontouring of most of the area of the Imperial City. Observations, with a view to the determination and elimination of an error in the geographical position of the detail of the original map, were also undertaken, as well as a careful traverse survey of the eastern boundary of the Delhi Province on the left bank of the Jumna river.

40. No 3 Party.—During the year under report the party carried out a survey, partly original and partly supplementary, of some 112 square miles of country near Campbellpore in the Attock district of the Punjab.

This survey was executed on the scale of 3 inches = 1 mile. It was called for urgently and at very short notice by the military authorities, for the purpose of an Artillery Practice Camp, and was put through in 22 days.

The fair map is being drawn for publication in the Northern Circle Drawing Office.

41. The Punjab Riverain Detachment.—The detachment continued the work of traversing, and laying down base lines. 977 linear miles of main circuits and 2,246 linear miles of minor traverses were run; 1,359 theodolite stations of the former and 8,535 of the latter were fixed in the area under water action of the rivers Indus, Chenāb, Rāvi, and Jumna in districts Dera Ghāzi Khān, Muzaffargarh, Multān, Ambāla and Sahāranpur. 537 corners of 179 squares were demarcated with permanent mark-stones on both banks of the Indus and Jumna rivers in districts Dera Ghāzi Khān, Muzaffargarh, Ambāla and Sahāranpur. These are to serve as bases for the future survey and demarcation of boundaries and fields in the beds of the rivers. 1,231 plotted and 355 boundary *masāvis* (settlement mapping sheets) on the scales of $\frac{1}{2,640}$ (Dera Ghāzi Khān) and $\frac{1}{2,280}$ (Ambāla), and 31

four-inch sheets were traced and supplied in time to the Settlement Officers. Besides these 191 miscellaneous traces were prepared and all the traverse stations marked during the year were plotted on 30 four-inch sheets. 5 riverain boundary sheets, (scale 4 inches to a mile), of the Beās (districts Kāngra and Hoshiārpur) were typed and finally examined.

The work was continued in the Kāngra district during the year. 414 traverse stations were computed and plotted on 2 four-inch sheets; the computation volumes of Pālampur, Kāngra and Nūrpur have to a great extent been completed. 1,187 plotted *masāvis* of 59 *tikās* (sub-villages) and 102 enlarged boundary *masāvis* of 32 villages of the Beās, on the scale 20 and 40 *karms* (one *karm*= 57·5 inches) to an inch, and 18 traces of 18 sheets, on the scale 4 inches to a mile, were supplied to the Settlement Officer, Kāngra. Besides these 10 miscellaneous traces were prepared.

The computation volumes of the Simla district were completed during the year.

The Kāngra Road Survey was carried on in continuation of the last year's programme with the object of co-ordinating the road and settlement boundaries. 43·30 miles of road, from mile No. 48 to 53·28, from mile No. 94 to 91·72, and from mile No. 89 to 53·26, were surveyed. 840 points were fixed with theodolite and 55 linear miles traversed. 29 sheets (scale 200 feet to an inch) of the main road, and 23 sheets (scale 50 feet to an inch) of 20 *bāzārs*, surveyed last year, were plotted, typed, examined and supplied to the Executive Engineer, Provincial Division, Kāngra, together with copies of *khasrās* (records of rights) relating to the same. 27 sheets (scale 200 feet to an inch) of the main road and 5 sheets (scale 50 feet to an inch) of 5 *bāzārs*, surveyed this year, are also almost ready and will be supplied to the Executive Engineer early during next winter. Besides these 7 indexes of last year's work and 5 of that of this year were prepared on the scale 4 inches to a mile.

At the end of August 1917 some traversing was undertaken for a three-inch military survey close to Campbellpore. 18 linear miles were run and the heights of traverse stations fixed.

42. No. 20 Party.—During the year under report, the party was employed on the survey of the cantonments and military stations of Rāwalpindi, Chitrāl, Drosh, Ghairat, Jhelum, Siālkot, Topa, Dharmsāla, Chaman, Jhānsi, Deoli, Neemuch, Nasīrābād, Ahmadnagar, Drazinda, Jandola, Jatta, and Zām on the sixteen-inch scale, and on the survey of the *bāzārs* of Rāwalpindi, Jhelum, Siālkot, Topa, Jhānsi, Deoli, Neemuch, Nasīrābād and Ahmadnagar on the scale of 64 inches to 1 mile. The triangulation and traversing of Chitrāl, Drosh, Ghairat, Dharmsāla, Jhānsi, Deoli, Nasīrābād, Ahmadnagar, Drazinda, Jandola, Jatta, and Zām were completed during the year. Jhānsi and Ahmadnagar have been traversed in advance for the year 1917-18.

Twenty-six fair sheets have been submitted for publication, sixty-five fair sheets are remaining and will be sent for publication by July 1918.

This party was transferred from the Northern to the Southern Circle from 1st April 1917.

Out-turn and cost-rates of Cantonment Surveys, 1916-17.

Cantonments.	Scales.	Out-turns.	Cost of Surveying and Mapping.	
			Total cost.	Cost-rates.
		Acres.	*Rs.*	*Rs. per acre.*
Rāwalpindi, Chitrāl, Drosh, Ghairat, Jhelum, Siālkot, Topa, Dharmsāla, Chaman, Jhānsi, Deoli, Neemuch, Nasirābād, Ahmadnagar, Drazinda, Jandola, Jatta and Zām ...	16-inch	23,859	45,619	1·9
Rāwalpindi, Jhelum, Siālkot, Topa, Jhānsi, Deoli, Neemuch, Nasirābād and Ahmadnagar...	64-inch	630	8,190	13·0
		24,489	53,809	

Alphabetical List of Cantonments and Military Stations surveyed and published in modern style, on the scale of 16 inches = mile, up to 1916-17.

(1) Bannu Cantonment.
(2) Dehra Dūn do.
(3) Fort Lockhart do.
(4) Guna do.
(5) Hangu do.
(6) Hāpur (Babugarh) Remount Depôt.
(7) Jullundur Cantonment.
(8) Kālka do.
(9) Kamptee do.
(10) Landour Cantonment.
(11) Meerut do.
(12) Quetta do.
(13) Quetta Civil Station.
(14) Rājkot Cantonment.
(15) Sahāranpur Remount Depôt.
(16) Sanāwar Cantonment.
(17) Saugor do.
(18) Thal do.

IV.—TRIGONOMETRICAL SURVEYS.

GEODETIC OPERATIONS.

43. No. 13 Party.—Astronomical Latitudes.—No latitude operations were undertaken, there being no officer available. The establishment of the party was employed at head-quarters.

The marking of Longitude Stations by means of suitably inscribed slabs was continued.

44. No. 14 Party.—Pendulum Observations.—No observations were made, as no officer was available. The establishment of the party was employed at head-quarters.

45. No. 15 Party.—Triangulation.—During the year under report the following series of triangulation were carried out:—

(a). The Madura Series. (96).

The building of this series, which lies along the parallel of 10°, between the Great Arc and South-East Coast Series, was completed in season 1911-12, *vide* General Report for that year.

The observations had not been taken up earlier, as the stations at the eastern end of the series lay in low flat country, covered with extensive palm groves and other large trees, which necessitated the use of a special trestle for the theodolite, and high masts for signals. These were constructed last year and the observations were carried out successfully, the series being completed by the first week of February 1917.

(b). The Bāgalkot Series. (97).

This series, which emanates from a side of the Mangalore Meridional Series, and extends along the parallel of 16°, to its junction with the Naldrug Series, was built and the observations satisfactorily completed.

The table below gives details regarding the triangulation.

PARTICULARS OF TRIANGULATION DURING 1916-17.

		Madura Series.	Bāgalkot Series.
Number of stations observed at		12	14
" " newly fixed		8	10
" " " built		.....	10
Length of triangulation completed in miles ...		68	102
" " still remaining to be done ...		.....	.....
Area of triangulation in square miles		781	1,400
Theodolites used		T. & S., 8", Nos. 1,055, 1,311	T. & S., 8", No. 1,311
Number of triangles observed		10	13
" astronomical azimuths observed ...		.....	.....
Maximum triangular error		4"·68	2"·17
Average " "		1"·53	1"·02
Mean errors in closing on the South-East Coast Series and the Naldrug Series respectively.	in Latitude ...	+0"·01	—0"·06
	" Longitude	—0"·09	—0"·09
	" Height in feet ...	.....	—0·5 feet
	" Azimuth	+3"·2	—1"·13
	" log. side (the unit being the seventh place of decimals).	—205	—68
Value of m		1·148	0·701
" M*		1·53	0·83

**Vide* Records of the Survey of India, Vol. IX, page 137.

46. No. 16 Party.—Tidal Operations.—During the year under report tidal registrations were carried out by means of self-registering tide-gauges at the stations given in the following list :—

	Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.		Remarks.
1.	Aden	1879 ...	Still working	38		
2.	Karāchi ...	1868 ...	1880	*13	50	*With a small tide-gauge.
		1881 ...	Still working	37		
3.	Bombay (Apollo Bandar)	1878 ...	,,	39		
4.	Bombay (Prince's Dock)	1888 ...	,,	29		
5.	Madras ...	1880 ...	1890	10	32	
		Restarted 1895	Still working	22		
6.	Kidderpore	1881 ...	,,	36		
7.	Rangoon	1880 ...	,,	37		
8.	Moulmein ...	1880 ...	1886	6	14	
		Restarted 1909	Still working	8		
9.	Port Blair	1880 ...	,,	37		

In addition to the above, the actual records of high and low water at Bhaunagar, Chittagong and Akyab were obtained from tide-pole readings taken during day-light by the Port Officers concerned.

From March 1916 hourly readings of a tide-gauge at Basrah, which was erected there by the military authorities, were supplied to this department. As soon as the readings for a whole year were available, they were reduced by the method of harmonic analysis, and the constants thus deduced were forwarded in April 1917 to the National Physical Laboratory, Teddington, England, where tidal predictions were made from them with the aid of the tide-predicting machine lodged there. One set of the predictions were received from the Laboratory on the 6th of August 1917. With this material, tide-tables for the port of Basrah from 1st September 1917 to 31st December 1918 were printed in the office of the Trigonometrical Survey at Dehra Dūn, and a supply of the same was despatched to the Director, Inland Water Transport, Basrah on 3rd September 1917.

Tidal registrations at the 9 observatories now working have, on the whole, been carried out satisfactorily and will be continued during the coming year.

All the above observatories were inspected during the year under report.

Owing to constant silting at the tidal observatory at Kidderpore and the difficulty of maintaining free communication between the sea and the tide-gauge well, the Port Commissioners of Calcutta built a new observatory in deeper water about 30 feet N.E. of the old observatory. In April 1917 the tide-gauge was removed from the old observatory and installed in the new one, where it has been working since.

In the following table are given the actual and decadal percentages of errors in the predicted times and heights of high and low water at all the stations where observations have been taken by selfregistering tide-gauges:—

PERCENTAGE OF ERRORS IN PREDICTED TIMES AND HEIGHTS.

YEAR.	AT OPEN COAST STATIONS.						AT RIVERAIN STATIONS.					
	Number of stations.	IN TIME.		IN HEIGHT.			Number of stations.	IN TIME.		IN HEIGHT.		
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.
		H.W.	L.W.	H.W.	L.W.	H.W.—L.W.		H.W.	L.W.	H.W.	L.W.	H.W.—L.W.
1907	6	84	83	98	98	98 99	2	58	47	78	60	96 90
1908	6	84	84	98	97	99 99	2	58	52	77	60	97 92
1909	6	85	86	97	97	97 98	3	61	59	69	65	93 92
1910	6	81	83	98	98	95 96	3	57	52	63	71	89 94
1911	6	84	84	98	99	97 98	3	65	51	68	66	90 90
1912	6	82	82	97	98	97 98	4	70	58	74	62	94 91
1913	6	83	82	97	97	98 99	4	68	55	70	58	94 88
1914	6	77	79	96	97	98 98	3	75	67	71	55	92 84
1915	6	82	82	98	98	96 96	3	76	66	73	67	94 92
1916	6	81	82	96	97	96 99	3	81	68	73	62	93 87
Average of ten years	...	82	83	97	98	97 98	...	67	58	72	63	93 90

47. No. 17 Party.—Levelling.—Four detachments were employed during the past season on levelling operations, the details of which are given below.

The out-turn, including branch lines, amounted to 540 miles of double levelling. The heights of 4 principal stations of the Great Trigonometrical Survey, and 10 primary and 627 secondary bench-marks were determined.

(a).—In Bengal.

Revision from Chāmpdāni to Burdwān along the Grand Trunk road. This line was originally levelled in 1862-63.

New levelling from Barākar to Burdwān along the Grand Trunk road. This completes the line from Benares to Burdwān.

New levelling from Dāmodar river to Barākar along the main road from Purūlia. This line is a continuation of that from Aurangābād *viâ* Daltonganj, Rānchī and Purūlia to Barākar.

(b).—In Bihār and Orissa.

New levelling from Aurangābād *viâ* Daltonganj, Rānchī and Purūlia to the Dāmodar river along the main roads. This line was carried on to Barākar.

New levelling from Barhī *viâ* Hazāribāgh to Rānchī along the P.W.D. road.

A detachment was engaged in the Sind-Sāgar Doāb on the selection and building of the stations of the triangulation required for the control of the rectangle survey of that tract. In all 51 stations were built and 6 Tower Stations of the Great Trigonometrical Survey repaired. The distance covered was about 195 linear miles. The work comprised a series between Khushāb and Leiah with a branch towards Miānwāli; the series will eventually be extended to the south towards Muzaffargarh

48. No. 19 Party.—Base Line Operations.—No Base Line work was practicable during the year, owing to the deficiency of officers.

Triangulation.—The detachment which carried out the traverse of the boundary of the Imperial Delhi Area last season was employed this year in the execution of a net-work of minor triangulation to provide points for the revision of the four-inch maps of Delhi and its vicinity. The triangulation embraces an area of 324 square miles between Latitudes 28° 30′ and 28° 47′ and Longitudes 77° 0 and 77° 20′.

Work during recess season.—The detachment was employed for a month and a half in preparing a synopsis of the triangulation for publication and was then broken up and its members transferred to other offices and parties.

MAGNETIC SURVEY.

49. No. 18 Party.—Magnetic.—The magnetic observatories at Dehra Dūn and Toungoo were inspected by the Officer in charge during the field season and a complete set of observations were taken at each for the comparison of instruments. The Alībāg and Kodaikānal observatories, under the Meteorological Department, were also visited for the same purpose.

No field observations were taken during the year.

Reports on the condition of the pillars of all the permanently marked repeat stations in India and Burma are being received yearly from the district officers and it is satisfactory to note that the pillars are all in good preservation.

Reduction of observations to epoch.—The reduction of the magnetic elements of all the field and repeat stations in India, Burma and Ceylon to the epoch 1909·0 was continued during the year and is nearing completion. The Declination and Horizontal Force data are ready for publication but, as the reduction of the Dip is well advanced, it is now considered desirable to await the completion of the latter and to publish all the magnetic elements of the field and repeat stations together. With the published values of these elements will be included the average annual change of each element at the field and repeat stations for each of the two periods 1901 to 1909·0 and 1909·0 to 1914. There will also be issued the monthly mean values of the elements at the observatories and a set of isomagnetic charts, as well as a set of charts showing graphically the monthly mean values and annual change of each element at the observatories from 1901 to 1909·0 and 1909·0 to 1914, *i.e.*, the average annual change will be given separately for each of the periods preceding and following the beginning of January 1909, the selected epoch of the survey, which is the date nearest to the point where an appreciable change is indicated in the curve of secular variation: the sections of the curve, prior to and subsequent to 1909·0 respectively are approximately straight lines, indicating that the annual change was nearly uniform both before and after 1909·0 but that its value altered at that epoch.

The magnetic elements at observatories.—The computation and tabulation of the provisional values of Declination, Dip, Horizontal Force and Vertical Force for the three observatories (Dehra Dūn, Toungoo and Kodaikānal) for 1916 have been completed; the mean values of these elements for the year 1916 derived from all days, excluding those of great disturbance, are given in the table below.

MEAN VALUES OF THE MAGNETIC ELEMENTS AT OBSERVATORIES IN 1916.

Observatory.	Latitude & Longitude.	Dip.	Declination.	Horizontal Force.	Vertical Force.
	° ′ ″	° ′	° ′	C. G. S.	C. G. S.
Dehra Dūn ...	30 19 19 N 78 3 19 E	N 44 37·9	E 2 11·0	·33050	·32627
Toungoo ...	18 55 45 N 96 27 3 E	N 23 8·5	W 0 8·4	·39018	·16676
Kodaikānal ...	10 13 50 N 77 27 46 E	N 4 22·4	W 1 27·9	·37633	·02878

PART 3.—OFFICE WORK.

I.—HEAD QUARTER OFFICES.

MAP PUBLICATION OFFICE (*vide* Index maps at end).

50. The most noticeable features in the work of the Map Publication Offices during the year are:—

(*a*) The large increase of work done in the Photo.-Litho. Office, the number of pulls and maps printed again being an easy record, the number of pulls on the machine and hand presses being 3,954,954 as against 2,975,149 last year and the finished maps printed being 1,080,573 as against 735,999 last year. As the machine power only increased 6 per cent. these results were accomplished by constant overtime work; they were caused entirely by increased military demands.

(*b*) The work in the Photo.-Litho. Office is reflected in the increased issues of maps in the Map Record and Issue Office 685,206 copies as against 437,131 last year. The work of this office is also largely increased by the demand for maps mounted on cloth and folded.

(*c*) The large increase in issues and in work done in the Mathematical Instrument Office is due entirely to compliance with military demands.

51. The classes of maps for the publication of which the Head Quarter Offices are responsible, are as follows:—

(*a*)—Topographical maps on the scale of 1 inch to 1 mile.
(*b*)—Topographical maps on the scale of ½ inch to 1 mile.
(*c*)—Topographical maps on the scale of ¼ inch to 1 mile.
(*d*)—Geographical maps on the one-millionth scale (about 1 inch to 16 miles).
(*e*)—Geographical maps on the two-millionth scale (about 1 inch to 32 miles).
(*f*)—General maps on smaller scales.
(*g*)—Special maps.

52. *(a)* **Topographical maps on the scale of 1 inch to 1 mile.**—During the year 64 modern sheets have been received and 85 have been published. The corresponding figures for the previous year being 128 and 204 respectively. This large reduction is due to certain parties surveying on the half-inch scale and to reduction of field work owing to the war.

The one-inch sheets of all areas surveyed up to 30th September 1915 have been published; of the sheets surveyed up to 30th September 1916, 54 remain to be published.

Index maps Nos. 4 to 6 at the end of this report show the progress made in the publication of the modern one-inch sheets and the table below gives the annual output of sheets since the modern topographical surveys were begun :—

Year.	Number of 1-inch Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1906-07	4	1	...	5
1907-08	16	15	22	53
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
1911-12	68	33	58	159
1912-13	104	60	58	222
1913-14	71	38	49	158
1914-15	97	48	9	154
1915-16	85	69	50	204
1916-17	**23**	**40**	**22**	**85**
Total Published ...	626	423	430	1,479
No. of 1-inch sheets which will not be published whose area is covered by published ½-inch sheets ...	...	30	...	30
Approximate number of 1-inch sheets in India ...	2,160	2,067	2,101	6,328
Approximate number remaining for publication ...	1,534	1,614	1,671	4,819

In addition to the above out-turn of modern one-inch sheets, 14 sheets prepared from modern revenue surveys have been received for publication, and 13 published as preliminary editions pending their topographical revision at some future date; these sheets are now published in colours, (*vide* Index maps No. 7 and No. 8); special editions of 30 modern one-inch sheets have been published at the request of Local Governments to show village boundaries.

To maintain stocks or to give effect to important changes due to the development of communications, 61 modern one-inch and 60 old style sheets on various scales have been reprinted. The increase in reprints mentioned in last year's report continues.

53. *(b)* **Topographical Maps on the scale of ½ inch to 1 mile.** (*Vide* Index map No. 9).—These form one of the most important series, as it has been decided that they should form the tactical map of India. The table below gives the annual output of sheets :—

Year.	Drawn from component one-inch sheets.	Surveyed on ½-inch scale.	Total.
1914-15	...	1	1
1915-16	21	4	25
1916-17	**50**	**6**	**56**
Totals	71	11	82

54. *(c)* **The map of India on the scale of ¼ inch to 1 mile.** (*Vide* Index map No. 10).—This map is prepared in "degree sheets" which include 1° of latitude and 1° of longitude, or the area covered by 16 one-inch sheets, or four half-inch sheets.

The following table shows the progress made in publication of sheets within India :—

Years of Publication.	Number of Degree Sheets Published.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1911-12	2	1	4	7
1912-13	3	1	1	5
1913-14	4	3	2	9
1914-15	1	3	3	7
1915-16	.....	1	4	5
1916-17	**1**	.....	**2**	**3**
Totals	11	9	16	36
Approximate number of degree sheets in India	170	140	140	450

The number of these sheets received for publication is now very small and will not increase until considerable progress has been made with the half-inch sheets, the intention in future being to draw "degree sheets" from reductions of the 4 component half-inch instead of the 16 one-inch sheets. Pending the preparation of these sheets from modern surveys 29 "degree sheets" have been published during the year as provisional issues; these are merely extracts from the engraved Atlas sheets (which will be gradually superseded) brought up to date as far as possible.

55. *(d)* **Geographical Maps on the one-millionth scale.** (about 16 miles to 1 inch). (*Vide* Index map No. 11).—During the year 12 sheets of this series were published, either new or in new style to supersede old editions, a considerable increase over previous years. Engraved editions of this series follow after the helio-zincographed editions. Several sheets which were published when this series was first commenced are now being modernised, so that the whole of the series may be of uniform style, and can be joined together or form a basis of maps of Provinces.

56. *(d)* **La Carte Internationale du Monde au 1,000,000.** (*Vide* Index map No. 12).—A full description of the genesis of this series was given in the General Report for 1913-14. Two sheets N. E. 44 and N. D. 44 have been published during the year. The sheets of this series are engraved.

57. *(e)* **Geographical Maps on the two-millionth scale.** (about 32 miles to 1 inch).—No sheets of this series were published this year, but good progress has been made in the drawing of two sheets, Madras and Bombay.

This series will in time supersede the Map of India and Adjacent Countries, scale 32 miles to 1 inch, of which the layered edition has made good progress and will be published in 1917-18.

58. *(f)* **General Maps on smaller scales.**—The new map of India on the four-millionth scale to replace the 64 miles = 1 inch map has made good progress and it is hoped will be published in 1917-18.

The plates of the other smaller scale maps maintained by the department have been corrected and kept up to date as far as possible.

The annual edition of the Railway Administration map, the triennial Railway, Road and Canal map, and a new map of the Province of Bihār and Orissa were also published.

59. *(g)* **Special maps.**—These are very numerous and include a geological map of Mysore, which necessitated many printings, many Artillery Practice Camp maps, a large scale map of Simla and various manœuvre and special maps for the General Staff, as well as maps for other departments and Local Governments.

60. Map Record and Issue Office.—The face value of maps received during the year under report, from the printing offices amounted to Rs. 5,09,155. This sum includes Rs. 7,435 and Rs. 6,384, the value of maps printed in the Engraving and Dehra Dûn Offices respectively.

Details of the classes of maps published during the year and their face value are given in Table IV on page 34.

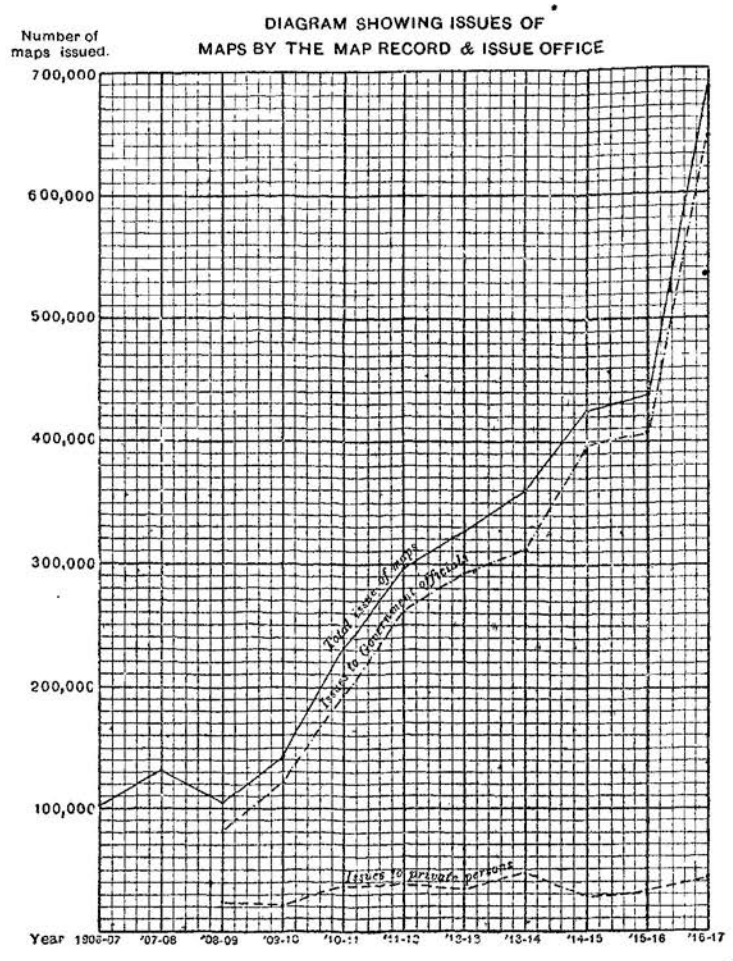
The total number of maps issued from the office during the year was 685,206 of an aggregate value of Rs. 3,44,398.

The details are as follows:—

	Government Officials.	*India Office.*	*Departmental Issues.*	*Private Individuals.*	*Map Agents.*	**Totals for 1916-17.**	*Totals for 1915-16.*
No. of maps	578,357	3,623	62,526	37,731	2,969	**685,206**	437,131
Value Rs.	2,65,568	3,995	37,675	34,578	2,582	**3,44,398**	2,17,853

The number of maps, covered by 1,765 separate orders, supplied to the military authorities was 465,740 of an aggregate value of Rs. 2,18,649-8-0.

The number of maps issued during the past year shows a very considerable increase, being 248,075 in excess of the year 1915-16 and if compared with the issues of the preceding ten years shows an increase of over six-fold. The major portion of this increase is due to the larger number of maps issued to Government officials which, during the year under report, totalled 644,506. There is, however, a distinct improvement in the sales to private individuals and map agents who took 40,700 copies as compared with 31,139 in 1915-16. The diagram on opposite page illustrates the issue figures during the past eleven years:—



The building of the new racks for maps in one of the map store-rooms, has been completed, these racks when full will accommodate the usual stock of 1,386 modern size sheets.

61. No. 1 (Head Quarters) Drawing Office.—Four sheets of the India and Adjacent Countries Series on the one-millionth scale have been completed and sent for publication. In view of towns and village sites being now classified according to their administrative importance, the style and size of the lettering in which their names appear varies accordingly. Four sheets, previously published, have been altered to accord with this classification and have been submitted for reprint, a further three sheets are being similarly dealt with. Four of the above mentioned sheets have been combined and published separately to form a map of the jute-growing districts. Three other sheets of this series are in various stages of compilation. The drawing of the "Madras sheet" of the Southern Asia Series, two-millionth scale, is nearly completed, that of the "Bombay sheet" is well advanced and the rough compilation and drawing of the "Calcutta sheet" of the same series has been started.

Patterns have been prepared for six sheets of the one-millionth India and Adjacent Countries Series for engraved editions. Patterns of six sheets of the one-millionth International Series, in which the values of heights and contours are in metres, were supplied to the Engraving Office and those of four other sheets are in hand. The compilation of the four-millionth map of India, which will supersede the present 64-mile map, has been completed and the material supplied to the Engraving Office. One degree sheet (scale $\frac{1}{4}$ inch to 1 mile) has been drawn and will shortly be submitted for publication. Nine sheets on the half-inch scale have been completed during the year and the drawing of three sheets is well advanced, they will be ready for publication early in December 1917.

The Mapping and Reprint Sections completed 35 degree sheets based on old Atlas sheets and 22 are in hand. These degree sheets are printed in black and classed as "Provisional Issues", they are brought up to date as regards railways, roads, canals, &c., from material supplied from extra-departmental sources. They will eventually be superseded by modern degree sheets in colours when the area comprising them comes under revision survey. A Provincial map of the Punjab, on the one-millionth scale, has been completed except for final examination and will shortly be sent to press, this map is drawn in the same style as, and based on, the one-millionth sheets covering the same area. Final corrections and additions were carried out on the new layered edition of the 32-mile map of India. The 32-mile Railway, Road and Canal map of India which was last revised in 1912 was corrected up to March 1916. The 64-mile map of India, showing railways open and under construction, was corrected up to March 1917 and various small scale maps of India were brought up to date. The originals of 136 maps on various scales have been brought up to date for the supply of reprints. Five small scale Administration report maps have been drawn and a considerable number of special military and extra-departmental orders have been carried out in this section. In addition a large number of maps drawn in circle offices and field parties have passed through the Drawing Office for minor corrections.

The Office Copy Section continues to maintain a complete record of all alterations and additions to published maps brought to notice by the local authorities, so that this information may be incorporated in new editions of maps. Such additions and corrections have been carried out on 3,055 maps. Office copies of 795 new maps have been made during the year to record similar changes. In addition this section has dealt with various questions relating to Revenue Survey maps, it has also supplied copies of original records to Government officials and private individuals requiring them.

The Examining Section has dealt with 420 cases during the year in addition to a considerable amount of miscellaneous work.

62. Engraving Office.—During the year under report three maps of the one-millionth India and Adjacent Countries Series, one International map on the same scale and one degree sheet were completed and transfers from the engraved plates supplied to the Photo.-Litho. Office. Eight International and three one-millionth maps are in hand of which three International and two one-millionth sheets are approaching completion.

The engraving of the new map of India on the scale of one over four-million, referred to in last year's report, has made good progress and it is hoped to supply transfers to the Photo.-Litho. Office by the end of December 1917. This map comprises four sheets and will be printed in three colours black, blue and brown, so that twelve copper plates are involved.

The periodic correction of the plates of the small scale maps of India, of Districts and of Index Charts has been carried out during the year. In this connection it was found necessary to engrave 2 new District maps, the plates of which had become obsolete.

All the plates of the 32-mile map of India have been revised and transfers supplied for reproduction.

The following maps were corrected on the copper plates:—The Provincial map of Mysore and Coorg, scale one inch to 16 miles, 30 Districts, 28 Indexes, one International and 6 Atlas of India sheets, the latter being revised for a reprint to replenish stock.

A good deal of work was done in connection with the engraving of titles on photogravure plates which had been prepared in the Photo.-Litho. Office. Miscellaneous work in the shape of engraving military manual scales, pocket compass cards, symbol guide cards, &c., was carried out.

In the *Printing Section* of this office 40,148 impressions were pulled as against 23,656 last year. Of this number 19,755 were for extra-departmental orders.

In the *Steel Facing Section* 300 plates were dealt with.

63. Photo.-Litho. Office.—The year 1916-17 has witnessed a steady increase in the demand for maps by the military authorities both for the use of the Expeditionary Forces and for use in India. This increase has resulted in the out-turn for the year constituting a record. Any future increase in the out-turn of the office can only be accomplished by an increase in the overtime employed on the Litho. machines so long as this branch of the office continues to be run by one "shift" of men, the alternative being to obtain more machines.

During the period under report 1,080,573 finished maps and diagrams were printed in the machine presses as against 735,999 during 1915-16. On an average between three and four printings were required to produce each finished copy, as was the case last year. The highest monthly out-turn was attained in March 1917 when 153,230 completed copies were produced on the machine presses.

Ten Litho. machine presses ran for the whole year. The total machine power was therefore 120 machine months as against 112 machine months for the previous year. There has thus been an increase of 6·7% in the utilised machine power.

The fifteen hand presses produced 40,235 impressions.

About 19% of the total out-turn represented maps printed for the department while the remaining 81% was composed of work done for the army and other departments.

The work done for the department includes 92 new and 139 reprint editions of modern style *one-inch sheets* in colours. Preliminary editions of 13 one-inch sheets were printed in colours, black and brown or black, and *Village Boundary editions* were published of 30 modern one-inch sheets. The total number of modern one-inch sheets printed or reprinted during the year was 281. Of the *half-inch series* 79 new sheets were printed in colours and 9 sheets were reprinted.

During the year 72 new quarter-inch *degree sheets* were printed, 29 being "Provisional Issues". In addition 78 degree sheets were reprinted either in colours, black and brown or black. Reprint editions of 2 *Atlas of India sheets* were also published.

Of old style sheets 60 were reprinted on the one-inch, half-inch and quarter-inch scales.

The *Negative and Retouching Sections of the Photo. Branch* have dealt with 4,452 and 4,778 negatives respectively as against 3,784 and 4,112 negatives last year. The *Helio and Vandyke Sections* have together turned out 7,496 plates as against 5,333 plates during 1915-16.

In the matter of methods and processes several important improvements have been brought into use. Transfers from engraved tint plates have been practically superseded by zinc tint plates etched in relief which are prepared in the Litho. Branch. This is the outcome of the investigations undertaken by Mr. Vandyke and referred to in last year's General Report.

A new method has been devised and taken into general use for the preparation of layer tint plates. By this method all tints are produced photographically by means of the half-tone screen at a considerable saving of time and labour as compared with the methods in use up till now. Green and yellow plates for forest and cultivation are now prepared photographically directly from the colour patterns prepared by Circle and Drawing Offices.

The *Photo. Engraving Section* during the year prepared 33 photogravure plates, 427 half-tone blocks and 316 line blocks, a total of 776 blocks and plates as against 692 during 1915-16. From the half-tone and line blocks an aggregate of 755,324 impressions were pulled compared with 980,593 impressions pulled during last year.

The *Type Printing Section* set up 8,216 pages of matter of which in all 1,311,014 copies were printed, 2,051,347 impressions being pulled.

Out-turn of Photo.-Litho. Office during 1916-17.

TABLE A.

1	2	3	4	5	6	7
Year.	Cost of office.	Value of out-turn at cost-rates.	Recovered in cash or by book-debit.	Number of maps printed.		
				Departmental.	Other than Departmental.	Total.
	Rs.	*Rs.*	*Rs.*			
1914-15	1,56,515	2,81,146	36,847	597	2,168	2,765
1915-16	1,80,603	3,41,782	63,791	847	2,229	3,076
1916-17	**1,79,661**	**3,47,271**	**36,009**	**793**	**3,391**	**4,184**

TABLE B.

1	2	3	4	5	6	7
Year.	Number of impressions pulled in Litho. Branch.	Number of half-tone impressions pulled.	Number of line-block impressions pulled.	Type Section Out-turn		
				Pages or items published.	Copies printed.	Impressions pulled.
1914-15	2,100,103	65,732	1,491,403	5,987	1,317,298	2,122,811
1915-16	2,975,149	86,373	894,220	5,383	1,143,075	2,053,663
1916-17	**3,954,954**	**115,486**	**639,838**	**8,216**	**1,311,014**	**2,051,347**

64. Mathematical Instrument Office.—During the year from 1st April 1916 to 31st March 1917, there was an increase in the demands made on this office (*vide* item 1 in para. 2) as well as in the value of work done (*vide* item 6 in para. 2), and there was respectively a profit of Rs. 69,785 and Rs. 44,439 against a loss of Rs. 6,145 and Rs. 30,421 in the year 1915-16.

2. Below are given the usual comparative figures for the last 3 years :—

	1914-15.	1915-16.	1916-17.
	Rs.	*Rs.*	Rs.
1. Total issues to Public Offices as shown in the Profit and Loss statements of stores.	4,16,642	2,51,818	5,52,655
2. Value of repairs to instruments received for repairs and returned in serviceable condition.	66,793	52,535	58,423
3. Value of instruments received from Government Officers when no longer required.	50,924	54,411	77,147
4. Book value of the stock of instruments, &c., in Serviceable Stores.	5,06,865	5,68,631	4,73,155
5. Book value of the stock of instruments, &c., in Repairable Stores.	62,347	70,896	1,15,805
6. Total value of work done in the Workshop ...	2,44,954	1,96,704	2,99,531
7. Value of instruments manufactured in the Workshop for Serviceable Stores.	87,421	71,641	1,76,119
8. Value of instruments purchased locally ...	9,792	11,255	1,09,039
9. Value of instruments and materials obtained from England through the Director General of Stores.	2,78,380	1,69,073	1,01,744
10. Average No. of employees and their pay ...	No. 317 } Rs. 80,947 }	No. 337 } Rs. 91,654 }	No. 353 } Rs. 1,02,664 }

3. During the year the stock of all the three stores, (the Serviceable, the Repairable and the Material Stores), was twice taken and the discrepancies noticed have been adjusted.

Table IV.—Departmental Publications, Calcutta, 1916-17.

Note.—For special publications at Dehra Dún, *vide*, pages 35 to 38.

Class of Maps.	Scale.	Number of different maps of each class received.		Number of copies printed.	Value.
		New Publications.	New Editions and Reprints.		
GEOGRAPHICAL MAPS.					*Rs.*
Maps of India	Various	.....	8	2,085	13,067
Southern Asia Series	1:2,000,000	.....	5	8,220	24,660
India and Adjacent Countries ...	1:1,000,000	7	9	15,244	15,244
Do. (International Series) ...	1:1,000,000	2	.....	600	600
TOPOGRAPHICAL MAPS.					
DEGREE SHEET SERIES.					
Modern	1″-4 miles	43	72	117,676	1,17,676
From Atlas material	Do.	29	6	10,055	10,055
HALF-INCH SERIES.					
Modern	1″-2 miles	84	9	80,528	80,278
ONE-INCH SERIES.					
Modern	1″-1 mile	92	139	132,362	1,31,112
Do. (Preliminary Editions) ...	Do.	13	7	8,360	7,960
Do. (Village Boundary Editions)	Do.	.....	30	3,000	6,000
Old Style Sheets	1″-1 mile & 1″-2 miles & 1″-4 miles	.....	60	10,425	15,487
MISCELLANEOUS.					
Atlas of India Series	1″-4 miles	.....	15	1,440	1,080
Provincial Maps	Various	1	3	400	1,175
District Maps	1″-4 miles	.....	7	1,350	1,600
Administration Report Maps ...	1″-8 miles to 1″-16 miles	1	45	2,500	938
Plans of Cities and Cantonments ...	Various	79	14	8,031	10,051
Index Maps	1″-32 miles	.....	26	25,150	4,748
Miscellaneous Maps	Various	410	138	258,707	67,424
Totals for 1916-17	.....	**761**	**593**	**686,133**	**5,09,155**
Corresponding totals for 1915-16 ...	.....	1,356	494	626,329	4,89,206

LETTERPRESS.

1. Survey of India. General Report, 1915-16. *Price Rs. 2 or 2s-8d.*

II.—DEHRA DŪN OFFICES.

TRIGONOMETRICAL SURVEY OFFICE.

65. Computing Office.—As forecast in last year's report the simultaneous reduction of the Burma Quadrilateral comprising the Burma Coast, the Mandalay Meridional, the Mandalay Longitudinal, the Manipur Meridional and the Manipur Longitudinal Series was finished during the year; and the adjustment of the Assam Valley, the Kohīmā, Cāchār, Nāgā Hills, Gāro Hills and the Khāsi and Jaintiā Hills Series was also completed. A preliminary adjustment of co-ordinates of stations of the Great Salween and the Upper Irrawaddy Series was carried out. The values of the heights of the secondary stations of the Great Arc Series, Section 18°—24°, were revised and brought into accordance with the revised heights of the principal stations of the same series. The observed azimuths at Poshkar and Gogipatri were revised. A considerable portion of the old triangulations executed in Baluchistān in seasons 1877—79 and 1887—89 by Captain Rogers and Messrs. Torrens and MacNair was readjusted in final terms. The heavy computations necessitated in preparing Professional Paper No. 16 and Part II of the Auxiliary Tables, 5th edition, were partly completed.

The following lines of levelling executed in 1914-15 but of which the final reduction has been held over till now, pending the receipt of additional data, have now been reduced;

(1) Benares to Barākar, (2) Bāgalkot to Bijāpur, (3) Howrah to Chāmpdāni and (4) Bankipore to Bihtā.

The computation and adjustment of lines of levels having been transferred to No. 17 Party, the Computing Office will not as a rule undertake this work in future. The services of the office, however, may be requisitioned under emergent circumstances. '*Vide* Trigonometrical Survey Order No. 214, dated 23rd July 1917'.

The reduction of simultaneous psychrometric observations at Dehra and Mussoorie was completed, and a number of investigations into the variation of refraction was carried out. Computations in connection with the traverse survey of New Delhi and the Nasirābād Cantonment were performed.

A list of all the protected stations of the Indian triangulation with their co-ordinates and other connected information is being compiled.

Requisitions for data were received from 24 departmental and non-departmental officials. In some cases, these requisitions could be met by supply of printed publications, in others it was necessary to extract the required information from manuscript records.

A large number of requisitions for forms was complied with.

121 Triangulation pamphlets were compiled and compared during the year, 90 were passed through the press and 104, including last year's undistributed pamphlets, were distributed.

Levelling Pamphlets Nos. 34 and 39 (Indian Series) and Nos. 93, 94 and 95 (Burma Series, final edition), Records of the Survey of India Volumes VIII and X and Tide Tables for the Port of Basrah, 1917-18, were bound in book form and distributed.

A portion of Rai Bahadur Lal Singh's work in Central Asia carried out while accompanying Sir Aurel Stein was revised.

Tables of clock rate corrections in connection with wireless longitudes were prepared.

Type Printing Section.—The following publications were printed during the year:—

(1) Triangulation Pamphlets ... ... 90.
(2) Levelling Pamphlets Nos. 93, 94 and 95.
(3) Tide Tables for the Port of Basrah.
(4) Professional Paper No. 16—pages 105 to end.
(5) Records of the Survey of India, Vol. X, 1915-16.

Observatories.—Meteorological observations were continued as usual. The Omori Seismograph has been working satisfactorily throughout the year. Two tremors of considerable intensity were recorded on 21st and 30th January 1917.

Photographs of the sun were taken on 322 days during the year, the sun being obscured on the remaining days. An unusually large sun spot was observed from 6th to 15th February 1917.

Preservation of Trigonometrical Stations.—1,046 stations were repaired by district officers at a cost of Rs. 5,263-12-2. Out of 357 districts from which the reports are annually due, 32 failed to make returns.

66. No. 2 (Dehra) Drawing Office.—During the year under report the work in this office was carried out by 5 sections.

(1) *Triangulation Section.*—Owing to the shortage of officers, the Triangulation, Cantonment, Half-inch and Miscellaneous Sections were amalgamated.

Only one half-inch sheet remains to be sent for publication, and no more will be taken up in this office.

(2) *Compilation Section.*—The rough compilation on the 12-mile scale of only four sheets of the area previously allotted to No. 2 Drawing Office up to Longitude 104°, remains in hand; none of the sheets east of Longitude 104° have yet been taken up. The compilation on the two-millionth scale of the Himālayan map, which will be published on the three-millionth scale, has now been taken up.

(3) *Stein Section.*—The compilation of the 49 sheets comprising Sir Aurel Stein's explorations in 1900-01, 1906-08 and 1913-15 has been practically completed; of these 5 sheets have been fair-mapped and sent for publication.

(4) A small section was employed, under the direct supervision of the Officer in charge, on the fair-mapping of the Mesopotamian sheets to be published on the half-inch scale. Four sheets were sent for publication.

(5) Throughout the year a section was employed under Colonel R. A. Wauhope, C.B., C.M.G., C.I.E., R.E., on the maps of Southern Arabia; all the area surveyed on the half-inch scale around Aden has now been mapped on that scale, and special surveys on larger scales, made during the operations of the Aden Boundary Commission and hitherto unpublished, have been mapped on the scale of survey.

Three sheets on the one-millionth scale, including the provinces of Asir, Yemen and Hadhramaut have been drawn and the two latter are under publication.

Photo.-Zinco. Section.—During the year 1916-17 the work undertaken comprised:—

Cantonment Maps.
Triangulation Charts.
Forest Maps.
Extra-departmental Maps.
Maps of Arabia.

During the year under review Mr. Vandyke was deputed to this office to instruct the Photo.-Zinco. Section in the process of transferring from plate to plate. This process has been in use since then and has worked well.

More accommodation has been provided for the retouchers and dufters which was much needed.

The new Graining and Litho. machines, which were erected during the early part of the year, have worked well.

The following table shows the work done in the last three years :—

Years.	No. of Subjects.	No. of Negatives.	No. of Pulls.	No. of Chocolate and Cyanotype prints.
1914-15 ...	1,898	2,267	345,526	663
1915-16 ...	2,065	1,717	307,357	1,209
1916-17 ...	**1,302**	**1,600**	**287,514**	**571**

The following is a summary of the work of the office during the year 1916-17 :—

Class of map.	Sheets sent for publication.	Sheets remaining in hand.	Remarks.
Rough compilation of map of Tibet for publication on the scale of $\frac{1}{4,000,000}$ ...	1	.....	Hill and skeleton.
Geographical maps, $\frac{1}{1,000,000}$ scale. (Fair sheets)	8	10	
Geographical maps, $\frac{1}{1,000,000}$ scale. (Rough compilation)	.....	4	
Geographical maps, $\frac{1}{3,000,000}$ scale. (Rough compilation)	.....	4	Himálayan map.
Sir Aurel Stein's exploration in Chinese Turkistán and Kansu in 1900-01, 1906-08 and 1913-15, for publication on the $\frac{1}{500,000}$ scale	5	44	The publication of these sheets is in abeyance pending Sir Aurel Stein's personal scrutiny of the originals on his return to India.
Regions between Leh and Karghalik mapped by Sir F. de Filippi's expedition in 1913-15, for publication on the $\frac{1}{500,000}$ scale	2	.....	
Degree Triangulation Charts of India ...	101	7	
Miscellaneous maps	19	.....	
Cantonment plans (corrections for 1916) ...	188*	5	*Corrections for 1916 carried out on 74 Cantonments and sheets stored away.
Cantonment plans (corrections for 1917) ...	28†	78	†Corrections for 1917 carried out on 14 Cantonments and sheets stored away. 34 Cantonments in hand.
Half-inch sheets	12	1	
Half-inch sheets of Mesopotamia ...	4	10	
Miscellaneous Extra-departmental maps ...	59	12	
Addendum to Levelling Charts Nos. 39, 93 and 94	3	.....	

67. Forest Map Office.—16,023 maps, diagrams and lists valued at Rs. 23,406, were issued during the year, an increase of 6,916 maps, &c., and Rs. 7,757 over the figures for last year. The net amount realised by sales to the public, was Rs. 1,038 for 669 maps, and by book-transfer Rs. 2,216 for 2,175 maps, &c.

In addition 1,120 reductions of 122 maps were supplied to the Survey of India, and 14,724 maps, &c., were received for storage. The increase in the issue of maps is due to more efficient handling, the result of the separation of the technical work in connection with the drawing and publication from that of the storage and issue of maps.

The maps prepared by the Forest Map Office fall into five classes, *viz*:—

(*a*) Reprints of Forest maps with corrections to date.
(*b*) Forest editions on the two-inch scale of modern one-inch sheets.
(*c*) Maps of Forest Circles and Divisions.
(*d*) Special maps to illustrate working plans, &c.
(*e*) Maps and diagrams to illustrate administrative reports, &c. of the Forest Department.

The following table shows the number of sheets dealt with during the year:—

Class of map.	In hand on 1st October 1916.	Received during the year 1916-17.	Drawn and sent for publication.	In hand on 30th September 1917.	Published during the year 1916-17.
(*a*) ...	113	48	53	103	18
(*b*) ...	88	54	35	104	43
(*c*) ...	36	1	7	30	2
(*d*) ...	6	76	66	16	68
(*e*) ...	22	5	13	14	8
TOTALS ...	265	176	174	267	139

III.—CIRCLE AND LOCAL DRAWING OFFICES.

68. No. 3 Drawing Office (Northern Circle).—During the year under report 25 one-inch sheets, out of the 37 previously surveyed and drawn by parties, were submitted for publication. The remainder are under correction in the Drawing Office and parties. Two one-inch sheets were corrected and brought up to date in the Drawing Office, for purposes of reprint, and are not included in the above number.

The proofs and colour patterns of 68 sheets, comprising one-inch, half-inch sheets, the sheets of the Simla 150 feet to the inch map, and Simla Guide Map (8 inches to the mile), were prepared and returned to the Superintendent, Map Publication, leaving a balance of colour patterns of 1 half-inch and 9 one-inch sheets still in hand.

Half-inch sheets compiled from the published sheets of modern one-inch and old style half-inch maps.—2 half-inch sheets were drawn in the Circle Drawing Office and submitted for publication, and 17 were received from the parties. Of these latter 13 had been sent for publication and 4 were undergoing correction at the end of the year.

On the basis of the one-inch sheets published up to 30th September 1917, there now remain for completion in the Northern Circle 133 half-inch sheets of the kind under consideration. Of this number, the fair-mapping of 27 sheets is in hand in the Drawing Office and parties, and the material for the preparation of 18 more is held in reserve for future requirements.

The above numbers do not include 10 sheets which are being, or are to be, drawn in No. 1 Drawing Office, nor 12 similarly allotted to No. 2 Drawing Office.

Hill-shaded sheets.—Hill-shaded sheets of 7 one-inch and 19 half-inch sheets were prepared and sent for publication, leaving in hand for hill-shading a balance of 8 one-inch and 2 half-inch sheets.

Special maps.—20 sheets of the Simla 150 feet to 1 inch map, 14 of which were drawn in No. 3 Drawing Office, were submitted for publication. A Guide Map of Simla was also drawn in this office in two sheets on the scale of 10 inches = 1 mile for publication on that of 8 inches = 1 mile.

Miscellaneous.—Traverse plots of stations of 23 *mauzas* consisting of 52 sheets, scales 16 and 32 inches to a mile, of Gondā district, were prepared for, and sent to, the Deputy Commissioner, Gondā. The cost of the preparation of these was lodged in the local treasury to the credit of the department.

69. No. 4 Drawing Office (Southern Circle).—During the year 31 one-inch sheets and 9 half-inch sheets, which had been surveyed and fair-mapped by parties, were finally examined and submitted for publication. At the end of the year every sheet, the survey of which was completed during the previous years, had been submitted.

Half-inch sheets compiled from published sheets of the one-inch map.—7 sheets were fair-mapped and submitted for publication and 13 sheets, which had been fair-mapped by parties, were finally examined and submitted for publication. At the end of the year 14 sheets were being fair-mapped in this office, 22 sheets were being fair-mapped by the parties and 12 sheets, the component one-inch sheets of which had been published, had not been commenced.

Quarter-inch sheets compiled from the published sheets of the half-inch map.—1 sheet was fair-mapped and submitted for publication. At the end of the year 3 sheets were being fair-mapped and 1 sheet, the component half-inch sheets of which had been published, had not been commenced.

The examination and colouring of the proofs of 63 sheets and the hill-shading of 49 sheets were completed and returned to the Superintendent, Map Publication.

A number of pupils were instructed in fair-drawing.

The Photo.-Zinco. Section undertook the photographic and zincographic work required in the circle.

70. No. 5 Drawing Office (Eastern Circle).—During the year 23 one-inch sheets were received from the parties and 19 were submitted for publication; 19 unpublished proofs were received and 17 were examined, coloured, hill-shaded and sent for publication.

Half-inch sheets compiled from the published sheets of the one-inch map.—25 sheets were completed during the year and 23 have been submitted for publication; 21 unpublished proofs were received, 10 of these were coloured, examined, hill-shaded and submitted for publication.

Quarter-inch sheets compiled fron the published sheets of the one-inch and half-inch maps.—5 sheets were completed in the Circle Drawing Office, and were submitted for publication.

All arrears pertaining to the preparation of colour patterns of one-inch sheets of the previous year were completed and submitted for publication.

Of the one-inch sheets, the survey of which was completed during the previous year, all have been submitted for publication, with the exception of 2 sheets not received from parties.

71. No. 6 (Simla) Drawing Office.—As during the previous year this office was organized in 2 sections.

The *Army Section* has dealt with the preparation of maps and plans for the use of the Army in India while the *Survey Section* has been employed on the preparation of trans-frontier maps on the one-millionth, quarter-inch and half-inch scales.

Most of the work of the *Survey Section* has consisted in redrawing in modern style, and sometimes to a reduced scale, the maps already existing, with the incorporation of such additional information of recent date as may have been available.

72. Bengal and Bihār and Orissa Drawing Office.—(*Imperial Standard Mapping Section*). This office continued under the direction of the Director of Surveys, Bengal, and is occupied in the drawing of one-inch sheets mainly from cadastral work and from four-inch thāna maps; these are published as preliminary editions pending their revision by the topographical survey. These sheets are however now being made as complete as possible by the addition of the hills and waste land areas from old maps and they are being published in colours. These two improvements for a short time reduced the out-turn, which has now again reached the normal.

In Bihār and Orissa 20 sheets were submitted for publication, of which 14 were new and 6 had previously been published, but were now re-submitted with hills and waste lands added.

In Bengal 12 new sheets were submitted for publication.

PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS.

73. Northern Circle.—*No. 3 Party* carried out a theodolite traverse of 183 linear miles for the Settlement Officer, Gorakhpur and furnished this officer with plot sheets on the scale 16 inches to a mile, for 38 villages.

Sind-Sāgar Party.—This party was formed on 15th June 1917 by the transfer of selected members of No. 4 Party to it, for the purpose of carrying out the rectangulation of the Sind-Sāgar Doāb in connection with the irrigation and subsequent colonization of that area. Its activities during the year under report have been confined to the preparations for the commencement of its work, and to training its establishment.

Punjab Riverain Detachment.—As in previous years this detachment was exclusively employed on local surveys in the Punjab. The details of the work done are shewn on pages 17 and 18.

74. Southern Circle.—The survey of cantonments and military stations was continued by No. 20 Party. The details of the work are given on pages 18 and 19.

The special survey on the scale of 1½ inches to a mile of reserved forests in the Hyderābād State was continued. No. 6 Party surveyed an area of 431 square miles and triangulated an area of about 350 square miles. The cost of this work is being borne by the Nizām's Government.

Two surveyors of No. 8 Party were placed on deputation during the field season with the Madras Forest Department to survey reserved forests on the eight-inch scale in the neighbourhood of Nilambūr in the Malabar district of Madras.

Section IX of the Tinnevelly-Travancore boundary in Madras was traversed and demarcated by No. 8 Party.

75. Map Publication Offices.—A very large proportion of the work of the Photo.-Litho. Office is for other Government offices, only 19% of their out-turn this year being departmental, a special feature being the large amount of work done for the General Staff owing to the war. The usual large number of weather charts was printed, as well as ruled paper for officers' note books in large quantities, and for the Archæological and other departments photo-gravure and half-tone photographs were also reproduced. The Drawing Office prepared Railway, Manœuvre, Postal and many other special maps, while the Map Record and Issue Office's main work is the issue of maps to other departments.

76. Mathematical Instrument Office.—The manufacture of heliographs and prismatic compasses Mark VII was continued during this year in larger quantities than in the previous year and practically all repair and manufacture work of a civil nature was stopped to facilitate military needs.

This office also supplied instruments to many Government offices, Provincial and Imperial.

77. Trigonometrical Survey.—The Punjab Government having decided to undertake the Great Indus-Jhelum Project for the irrigation of the Sind-Sāgar Doāb, asked for triangulation to serve as the basis for the lay-out of the tract in rectangles according to the established system of that Province, and a beginning was made with the reconnaissance of the northern part of the area and with the building of the stations.

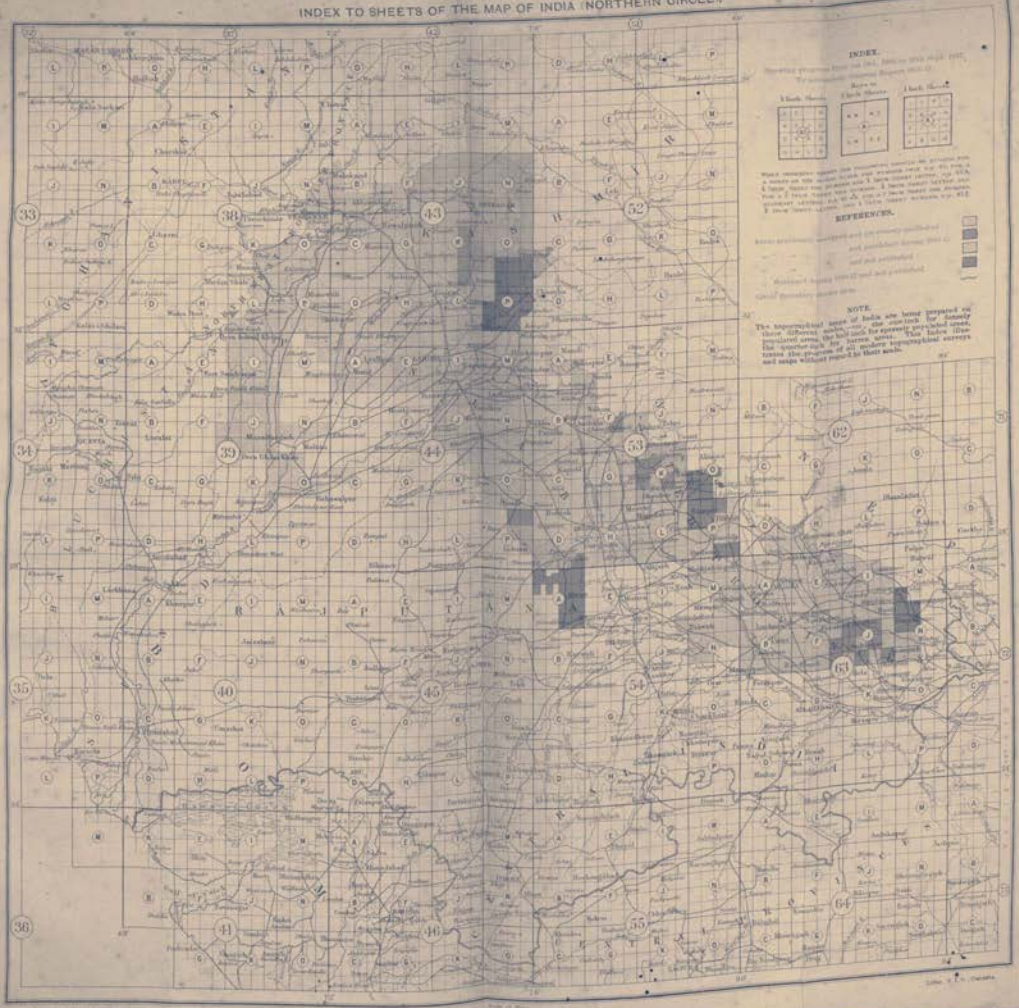
78. Dehra Dun Offices.—A large number of maps were produced for other departments of Government, particularly for the General Staff. The demands for maps of the Forest Department, which are continually on the increase, were met to the utmost extent of its capacity by the Forest Map Office.

The Computing Office complied with many requisitions for data.

LIST OF INDEX MAPS.

1. Modern surveys and publication, Northern Circle.
2. „ „ „ „ Southern „
3. „ „ „ „ Eastern „
4. Publication of modern one-inch series, Northern Circle.
5. „ „ „ „ Southern „
6. „ „ „ „ Eastern „
7. „ provisional editions of one-inch series, Northern Circle.
8. „ „ „ „ „ Eastern „
9. „ modern half-inch series for India.
10. „ „ quarter-inch „ „
11. „ 'India and Adjacent Countries' series, scale $\frac{1}{1,000,000}$.
12. „ Indian sheets of "La Carte Internationale du Monde," scale $\frac{1}{1,000,000}$.
13. „ 'Southern Asia' series, scale $\frac{1}{2,000,000}$.
14. Progress of the Great Trigonometrical Survey.

INDEX TO SHEETS OF THE MAP OF INDIA (NORTHERN CIRCLE).



MODERN SURVEY & PUBLICATION

(Northern Circle).

INDEX TO SHEETS OF THE MAP OF INDIA (SOUTHERN CIRCLE).

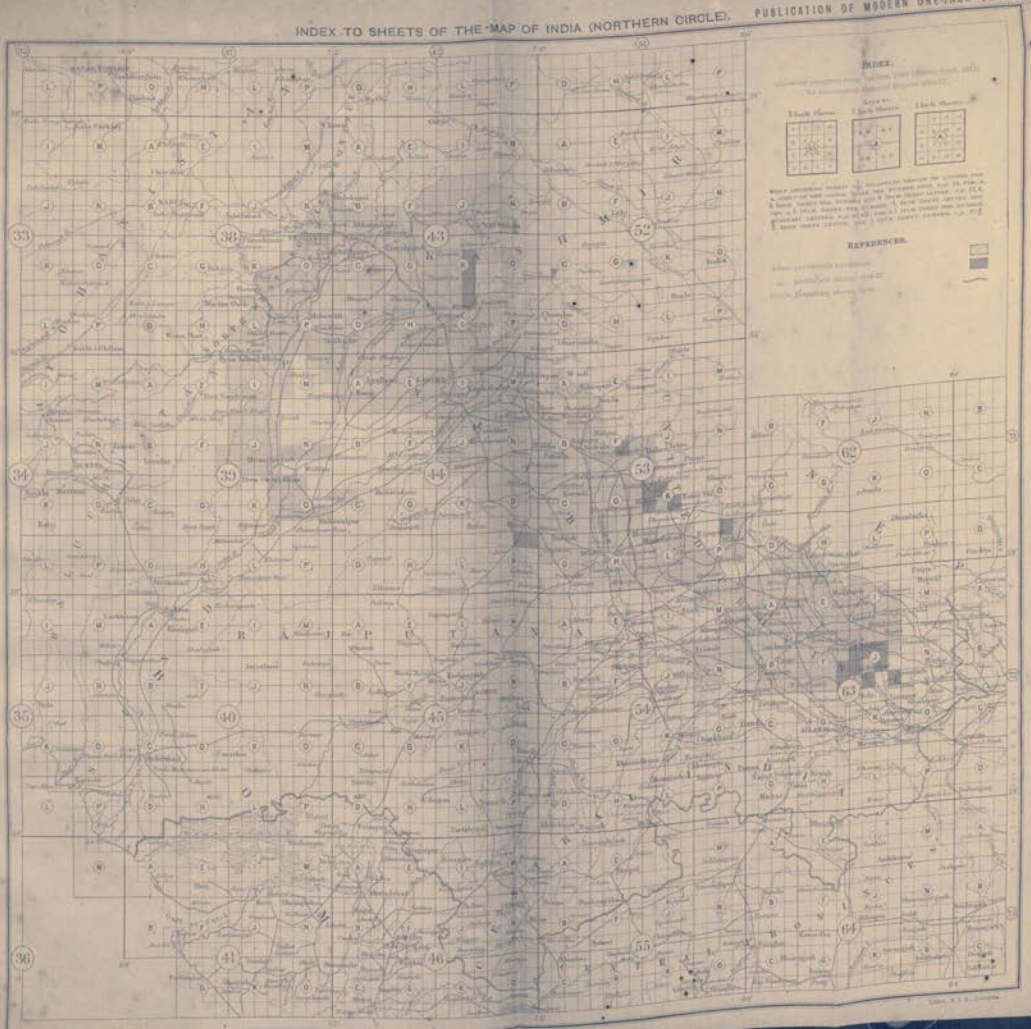
SURVEY & PUBLICATION

(Southern Circle).

INDEX TO SHEETS OF THE MAP OF INDIA (EASTERN CIRCLE).

MODERN SURVEY AND PUBLICATION

(Eastern Circle).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MODERN ONE-INCH PUBLICATION

(Northern Circle).

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MODERN ONE-INCH PUBLICATION

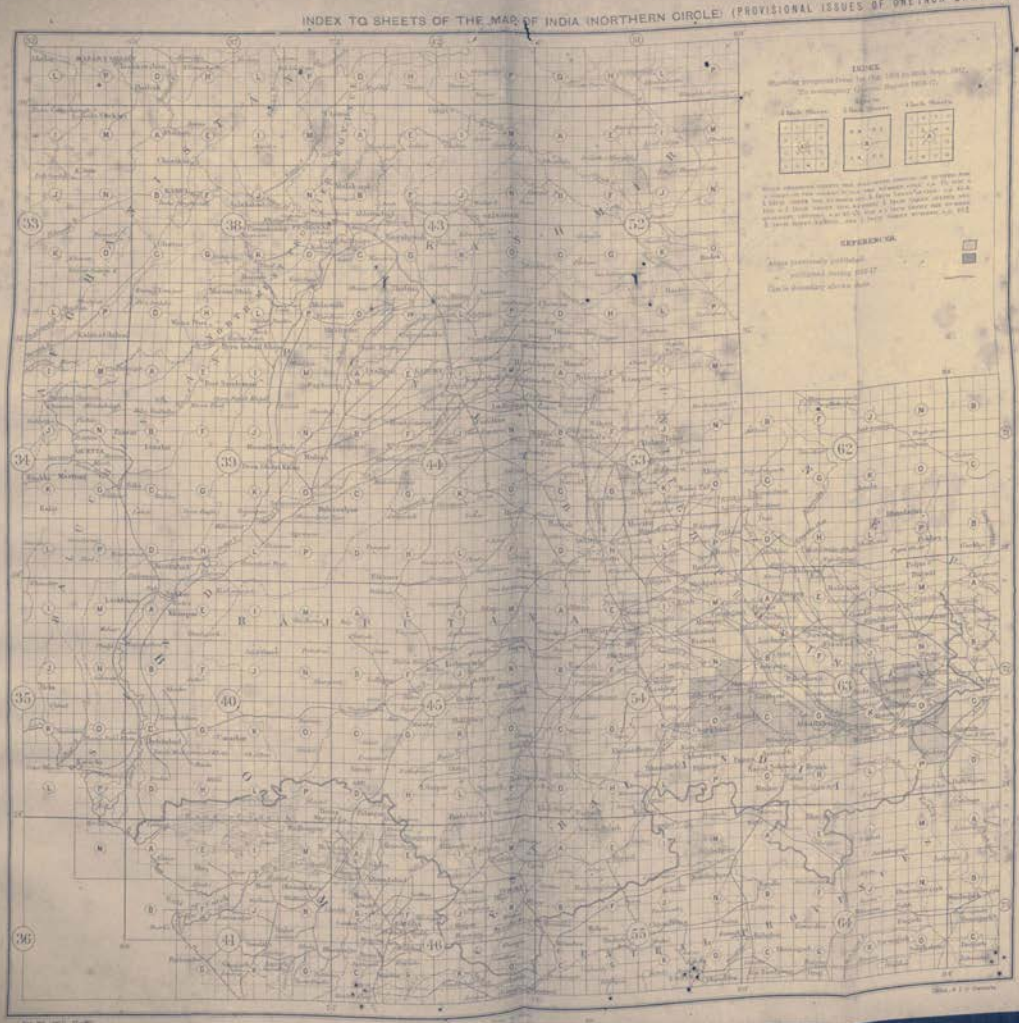
(Southern Circle).

INDEX TO SHEETS OF THE MAP OF INDIA (EASTERN CIRCLE).

MODERN ONE-INCH PUBLICATION

(Eastern Circle).

INDEX TO SHEETS OF THE MAP OF INDIA (NORTHERN CIRCLE) (PROVISIONAL ISSUES OF ONE INCH SHEETS).



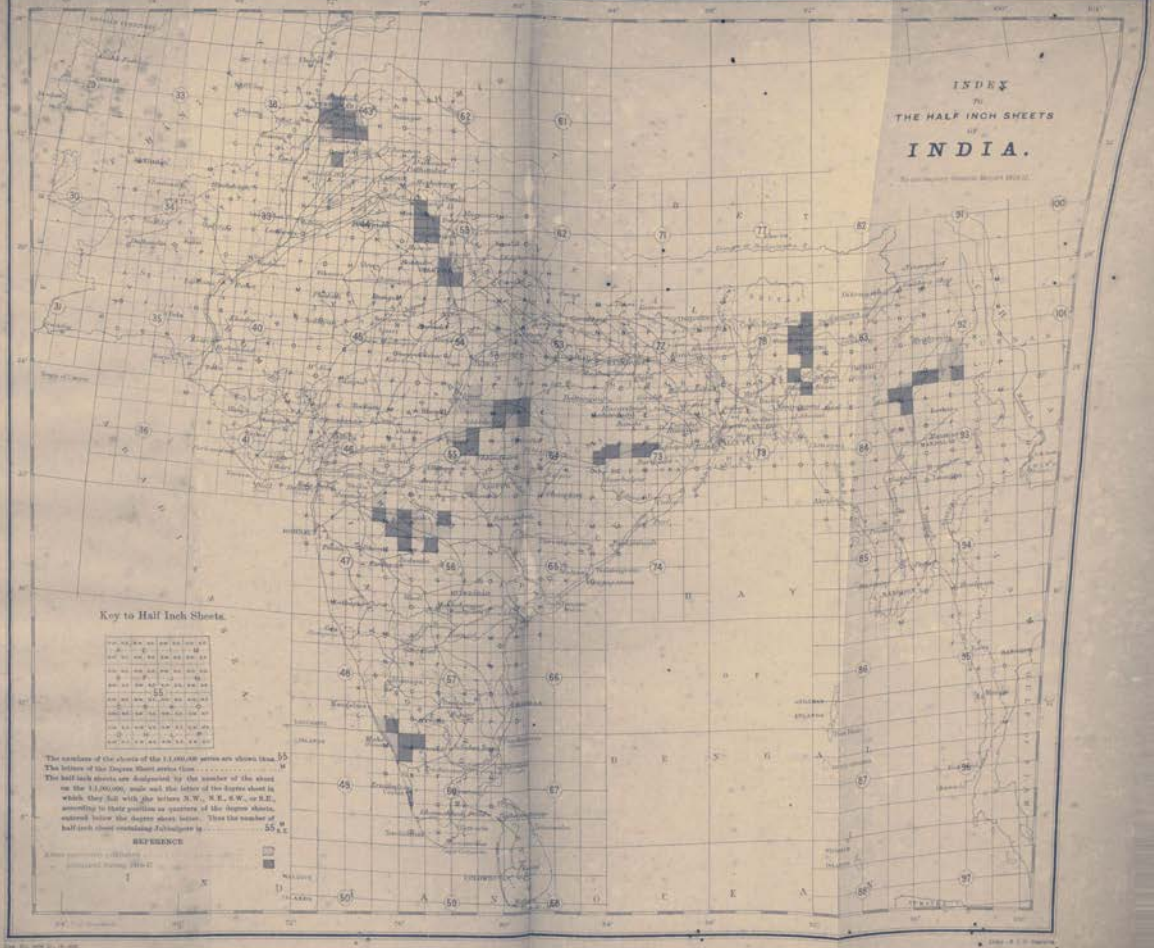
PROVISIONAL ONE-INCH PUBLICATION

(Northern Circle).

INDEX TO SHEETS OF THE MAP OF INDIA (EASTERN CIRCLE). (PROVISIONAL ISSUES OF ONE-INCH SHEETS).

PROVISIONAL ONE-INCH PUBLICATION

(Eastern Circle).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TO
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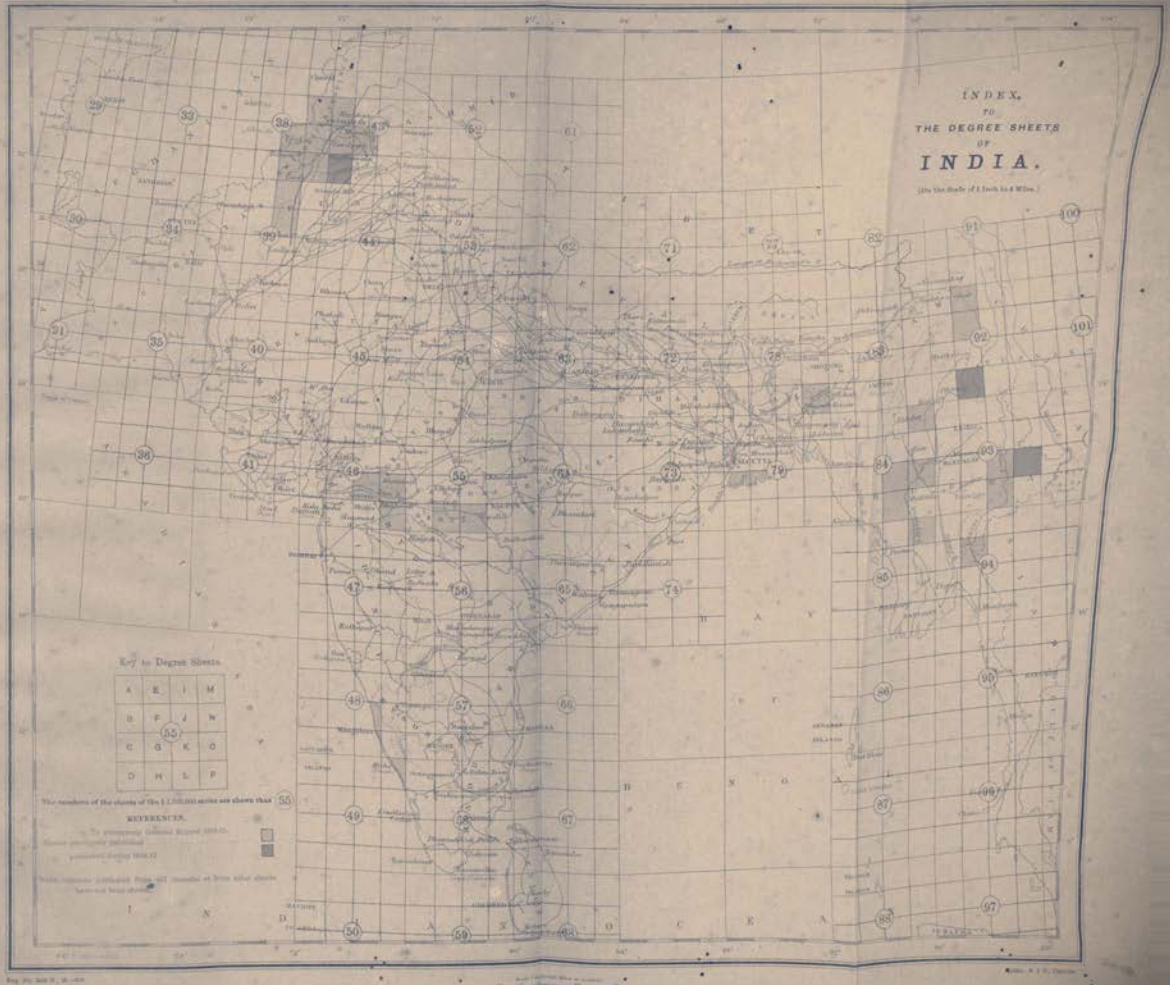
OF
INDIA.
Key to Half Inch Sheets.
The numbers of the sheets of the 1:1,000,000 series are shown thus 55
The letters of the Degree Sheet series thus M
The half-inch sheets are designated by the number of the sheet on the 1:1,000,000, scale and the letter of the fourths sheet in which they fall with the letters N.W., S.E., S.W., or S.E., according to their position as quarters of the degree sheets, entered below the degree sheet letter. Thus the number of half-inch sheet containing Jubbulpore is 55 S.E.
REFERENCE
INDIA
BURMA
BAY OF BENGAL
ARABIAN SEA

HALF INCH SERIES.


INDEX,
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Key to Degree Sheets.
A E I M
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55
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The numbers of the sheets of the 1,000,000 series are shown thus 55
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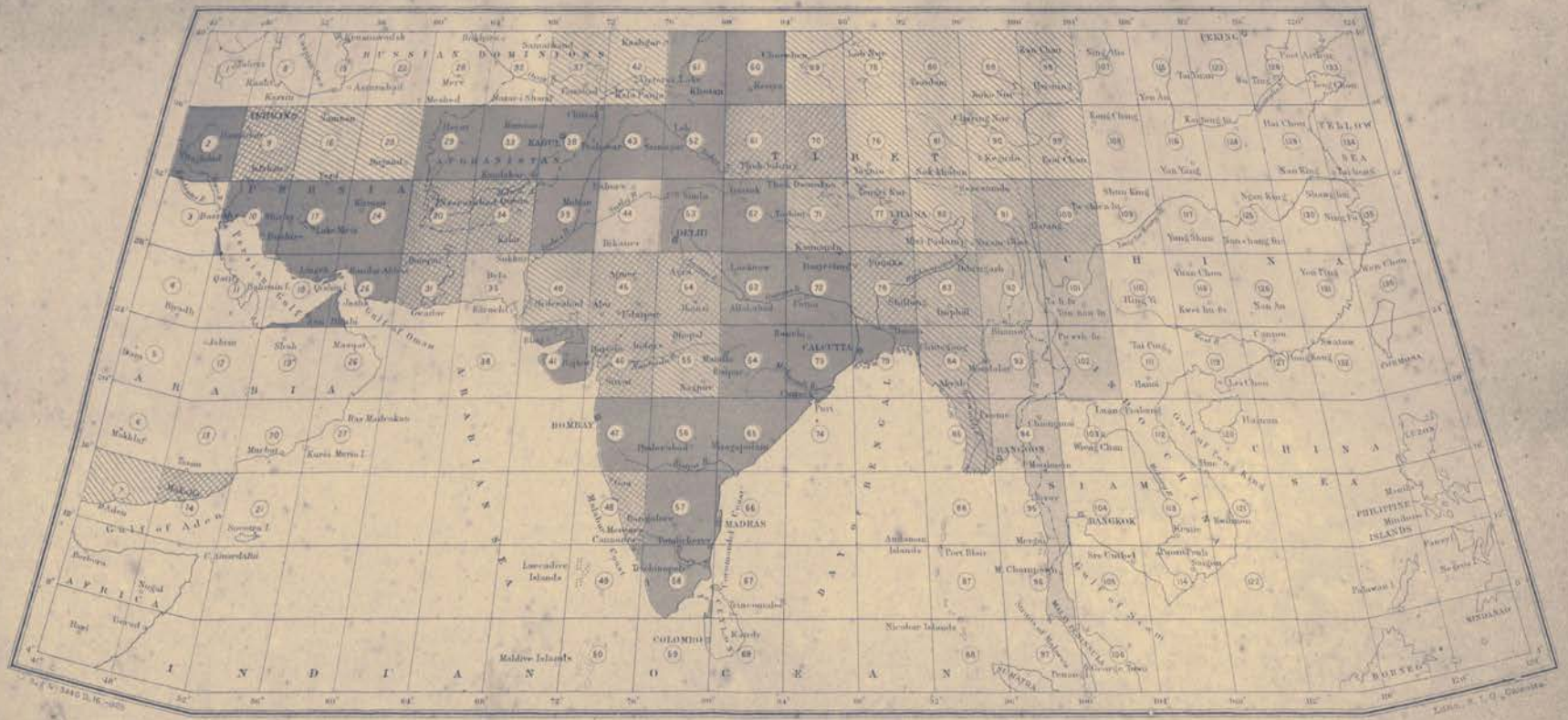
DEGREE SHEET SERIES

Scale 1 Inch to 4 Miles.

INDEX TO THE SHEETS OF THE

INDIA AND ADJACENT COUNTRIES SERIES

on the Scale of 1:1,000,000, or 1·014 inches to 16 miles.



Scale of Miles

REFERENCE

Sheets published without contours & layers

" with contours & layers

" under publication

" in hand

To accompany General Report 1918-19

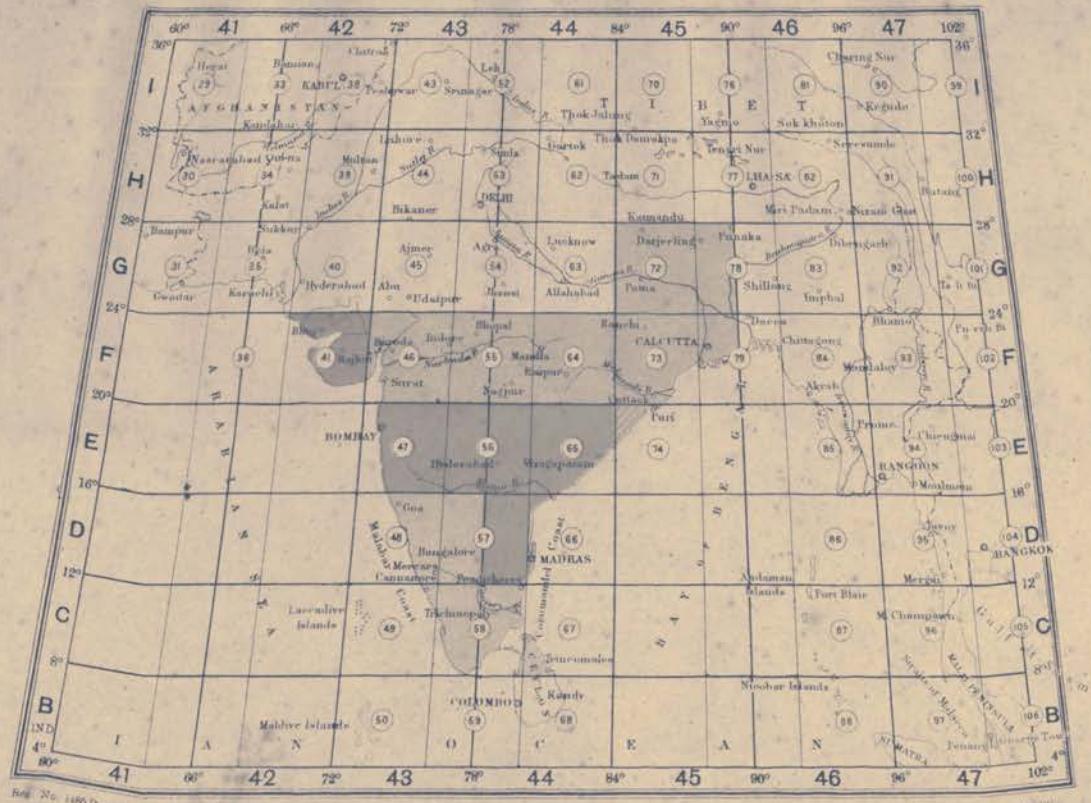
INDIA AND ADJACENT COUNTRIES SERIES

Scale 1:1,000,000.

INDEX TO THE SHEETS OF THE

CARTE INTERNATIONALE DU MONDE

on the Scale of 1:1,000,000.



Reg. No. 1485 D—14.—250.

The thick lines show the margins of the sheets of the International Map of the World, Scale 1:1,000,000. Each sheet is designated by the letter N (Northern hemisphere), followed by the marginal letter and number corresponding to its position, e.g., the sheet which includes Bombay is N.E-43.

The figures in circles are the numbers of the sheets of the India and Adjacent Countries Series on the Scale of 1:1,000,000.

Scale 1/1,000,000

Miles 200 0 200 400 600 800 Miles

REFERENCE

Sheets published .....

" under publication .....

" in hand .....

To accompany General Report 1916-17.

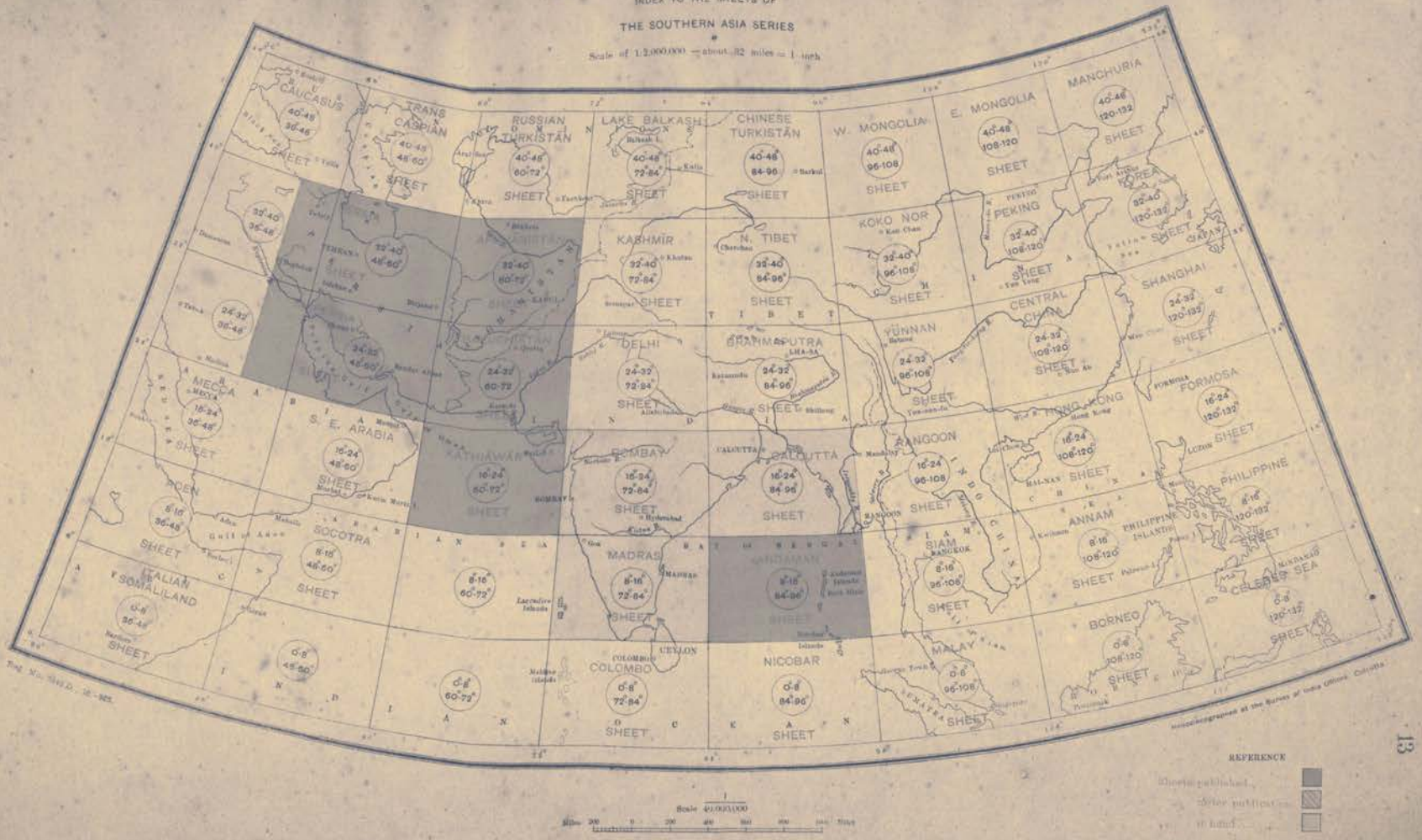
INTERNATIONAL SERIES

Scale 1:1,000,000.

INDEX TO THE SHEETS OF

THE SOUTHERN ASIA SERIES

Scale of 1:2,000,000 — about 32 miles = 1 inch



REFERENCE

Sheets published

Other publications

In hand

To accompany General Report 1916-17.

SOUTHERN ASIA SERIES

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INDEX
to the
GREAT TRIGONOMETRICAL SURVEY
of
INDIA
Corrected to October 1917
(To illustrate the Report for the year 1916-17)
BAY OF BENGAL
INDIAN OCEAN
CEYLON

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